Peak Performer 1 FID
(920- Series)
User Manual

Peak Laboratories, LLC

www.peaklaboratories.com

650-691-1267

Version 5.1
6/18/14

Forward

This manual is a reference guide for the operation of the Peak Performer 1 series of gas analyzers. The Peak Performer 1 should only be operated by trained personnel familiar with the safe operating procedures of the analyzer.

The following cautions should always be considered:

High voltages are required for proper detector operation and are present when the unit is energized.

High operating temperatures are required for proper detector and chromatographic operation. Hot surfaces may be present when the unit is energized

Illustrations and photographs contained herein are for example only. Actual configurations may vary depending on specific application and installed options.

Improper installation, operation or service of the analyzer can cause permanent damage to the instrument. The analyzer is designed to be operated with all covers installed, connected to a properly grounded 3 conductor AC line source.

In event of fire, Class A, B, or C fire extinguishers can be used.

The Peak Performer 1 must have standard electrical power and applicable gas supply pressures as noted on the test documentation for proper operation. Permanent damage and voiding of the warranty may result.

Operators should not attempt to repair the instrument except under directed to do so by factory trained service technicians. Permanent damage and voiding of the warranty may result of improper operation.

The FID utilizes low flows of pure hydrogen and clean air to generate a small continuously burning flame within the FID Tower. Use standard gas handling practices for combustible gases when working with the FID equipped PP

H2 venting, H2 shut-off valve and H2 supply safety equipment must be supplied by customer.

Glossary and Terms

FID	Flame Ionization Detector
Methanizer	Ruthenium Oxide Catalyst
HSD	HayeSep D column packing material
Molecular Sieve	Zeolite column packing material
Unibeads	Silica column packing material
Gas Purity	Amount of undesired elements in a gas supply Span
Gas	Gas supply with known, certified amounts of specific compounds
Response Factor	Proportionality factor between area count units and concentration units
Name	Peak identification tag
PkCen	Expected peak retention time (in seconds)
LW	Typical time span measured from the start of the peak's baseline rise to the peak apex *"PkCen"* (in seconds)
RW	Typical time span measured from the peak's apex *"PkCen"* to the end of the peak's baseline decline (in seconds)
PkWin	Total tolerance window (in seconds) for assignment of a *"Name"* to a quantified chromatographic peak. The tolerance window is centered upon the "*PkCen"* value
PkHgt	Variable for establishing the cross-over point in peak detection modes. Chromatographic peaks higher than this parameter will be quantified using the *"Variable"* mode heights, peaks with height less than or equal to *"PkHgt"* will be quantified using the *"ForceB"* mode.
Flt	Convolution filter value expressing the overall peak shape. Flt = 2 is recommended for sharp, narrow peaks such as H2, and Flt = 8 is recommended for broad peaks such as CO.
VICI	Valco Instruments Company, Inc. (www.vici.com)

Table of Contents

1.0	**Introduction**	7
2.0	**Installation Considerations**	8
2.1	Unpacking Instructions	8
2.2	General Considerations	8
2.3	Electrical Connections	8
2.4	Rack Mount Specifications	9
2.5	Gas Supplies and Connections	11
2.5.1	Carrier Gas Supply	12
2.5.1.1	Carrier Gas Purity	13
2.5.1.2	Carrier Gas Purity Requirements	14
2.5.1.3	Carrier Gas Connection	14
2.5.2	FID Hydrogen Gas Supply	15
2.5.2.1	FID Hydrogen Gas Generators	16
2.5.2.2	FID Hydrogen Gas Cylinders	16
2.5.3	FID Zero Air Gas Supply	16
2.5.4	Actuator Gas Supply	17
2.5.5	Sample Gas Supply	17
2.5.5.1	External Calibration Gas Supply	17
2.5.5.2	Second Sample Supply	18
2.5.6	Calibration Gas Connection for Analyzer with Internal Blender	18
2.5.6.1	Span Gas Supply (For Internal Span Gas Blender)	18
3.0	**Standard Start-up Procedure**	**19**
3.1	Quick Start Sequence	19
3.2	Column Conditioning	20
3.3	Detector Conditioning	21
3.4	Igniting the FID Flame	22
3.5	Sample Analysis	22
3.6	Calibration	22
3.6.1	Establishing New Instrument Response Factors	23
3.7	Shutdown and Transport	23
4.0	**Peak Performer 1 Operator Interface**	**24**
4.1	Set-up Screen	25
4.1.1	Set-up Screen Upper Section	25
4.1.1.1	Set-up Screen Upper Section Button Functions	25
4.1.2	Set-up Screen Middle Section (Power-up)	26
4.1.2.1	Set-up Screen Middle Section Button Functions (Power-up)	26
4.1.3	Set-up Screen Middle Section (Normal)	27
4.1.3.1	Set-up Screen Middle Section Button Functions (Normal)	27
4.1.4	Set-up Screen Lower Section	28
4.1.4.1	Error Messages on the Set-up Screen Lower Section	28
4.1.4.2	Clearing Error Messages on the Set-up Screen	29
4.1.4.2.1	Set-up Screen Lower Section Button Functions	29
4.2	Analog Interface (Trend and Recorder Output) Screen	31
4.2.1	Analog Interface Screen Button Function	32

4.2.2	Analog Interface Connections	33
4.2.3	Analog Interface Wiring Breakdown	33
4.3	Calibration Database Screen	34
4.3.1	Calibration Screen Button Functions	34
4.3.2	Calibration	34
4.3.2.1	Establishing New instrument Response Factors	35
4.4	Analysis Database Screen	36
4.4.1	Analysis Database Parameters	36
4.4.2	Analysis Screen Button Function	37
4.5	Event Program Editor Screen	38
4.5.1	Event Program Commands	38
4.5.2	Event Editor Screen Button Function	39
4.6	Stream Selector Sequence Editor Screen (Optional)	39
4.6.1	Stream Selector Commands	39
4.6.2	Stream Selector Program Editor Screen Button Function	40
4.7	Run / Chromatogram Screen	40
4.7.1	Run Screen Button Functions	41
4.7.2	Continuous Monitoring Analysis	42
4.7.3	Manual Screen (Sub-Screen of Run Screen)	42
4.7.3.1	Manual Screen Button Functions	43
4.7.4	Display Screen (Sub-screen of Run Screen)	43
4.7.4.1	Display Screen Button Functions	43
5.0	**Peak View Software**	**44**
5.1	System Requirements	44
5.2	Installing the Viewer Software	44
5.3	Starting the Viewer Software	44
5.4	COM1 / COM2 Port and Cable Wiring	44
5.5	Viewer Software Window	45
5.5.1	File Menu on the Viewer Taskbar	46
5.5.1.1	Communication Setting Window	47
5.5.1.2	Viewer Line Details Window	49
5.5.2	Start Menu on the Viewer Taskbar	49
5.5.3	Stop Command on the Viewer Taskbar	50
5.5.4	Chrom View Window and Chromatogram Viewer Window	50
5.5.4.1	Chromatogram Files	51
5.5.4.2	File Menu on the Chrom Viewer Taskbar	51
5.5.4.3	Viewer Menu on the Chrom Viewer Taskbar	52
6.0	**Communication Port Protocols and Data Formats**	**53**
6.1	COM1 / COM2 Port and Cable Wiring	53
6.2	Port 1 Protocol	53
6.2.1	COM 1 Port Settings	53
6.2.2	Peak View Output (Columns format in .CSV file)	54
6.2.3	Detector Output	54
6.2.3.1	External Start Command String	54
6.2.3.2	Detector Signal Data String	55
6.3	Port 2 Protocol	55
6.3.1	COM 2 Settings	55
6.3.2	COM 2 Port PLC Output Format	56
6.4	Modbus Protocol and Register Map for Peak Devices	57
6.4.1	Mode of Transmission	57
6.4.2	Modbus Packet Structure	57
6.4.3	Packet Communications	58

6.4.4	Modbus Data Format	60
6.4.5	Broadcast Packets	61
6.5	Trend / Analog Outputs	64
6.6	Setting up a RS485 Network	64
6.6.1	RS232 to RS485 Converters	64
7.0	**Chromatographic Principles**	**65**
7.1	Sample Injection	65
7.2	Carrier Gas Purification	65
7.3	Component Separation	66
7.4	Venting and Flow Balancing	69
7.5	Effects of Temperature and Flow on Analytical Columns	72
7.6	Peak Identification and Quantification	75
7.6.1	Peak Quantification : Fixed Mode	79
7.6.2	Peak Quantification : Forced Baseline Mode	79
7.6.3	Peak Quantification : Variable Mode	80
7.7	Chromatographic Stabilization of the Analyzer When Injecting O2 Samples	84
8.0	**Flame Ionization Detector (FID)**	**87**
8.1	Flame Ionization Detector Principles	87
8.2	Temperature Effects Within the Methanizer and FID Tower	89
8.3	Detector Flow Rate Effects	90
8.4	Resolving Random Spikes on the FID Baseline	91
8.4.1	Restriction of Water Flow Out of the FID Drain Line	92
8.4.2	Moisture Trapped Within the FID Tower	92
9.0	**Analyzer and FID Maintenance and Service Procedures**	**94**
9.1	Peak Performer 1 System Block Diagram	95
9.2	Monitor Regulator Pressures	96
9.3	Verifying Valve Integrity (Carrier Blank, Zero Gas)	97
9.4	Start-up Sequence for Replacement Methanizer	98
9.5	Adjusting the Display Contrast	102
9.6	Altering the Analytical Range of the Instrument	103
9.7	Testing the Heater Resistance	104
9.8	Main DC Power Supply Replacement	105
9.9	Adjusting the 5 Volt DC Power Supply	108
9.10	COM 1 (Viewer) Connections on Multiple Analyzers to a Single Computer	109

1.0 Introduction

The Peak Laboratories Peak Performer 1 (PP1) FID gas analyzer is a trace level gas analysis system capable of detecting part per trillion (ppt) concentrations of Hydrocarbons gases in a variety of sample matrices.

Due to the specific nature of the detection method, analysis times are rapid and chromatographic complexity is minimized. The result is a simple and reliable system capable of following rapid trends in component concentration in laboratory, field, and process gas applications.

The Peak Performer 1 has a fully integrated, stand-alone microprocessor operating system. Key functions of the operating systems include detector and temperature control, data collection and analysis, and operator / data interface

Sampling hardware	4, 6, and 10 port VICI valves
Column oven	Covered
Type	Isothermal, Mandrel Heating
Capacity	Single or Multiple 1/8” Columns
Temperature range (Ambient)	50°C –> 295°C
Temperature accuracy	± 0.5°C
Power required	160 watts maximum

2.0 Installation Considerations

2.1 Unpacking Instructions:

Remove the Peak Performer 1 from the packing material or traveling case, taking care to not scar the exterior surfaces of the analyzer.

Set the analyzer on a firm, even surface and remove the protective plastic wrap.

Each analyzer ships with adequate supplies for installation. Be certain to remove the installation accessories (tubing, power cord, compression fittings, etc.) from the packing materials.

Remove the sleeve containing the Certificate of Conformity and Installation CD from the analyzer top panel.

All shipping materials are reusable, please recycle these materials appropriately.

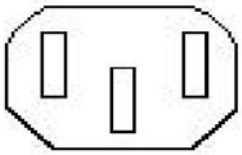
2.2 General Considerations

- Analyzer size is 26” L x 17” W x 7” H
- Maximum operating environment for the PP1 analyzer is 30°C
- Minimum operating environment for the PP1 analyzer is 15°C
- Power consumption is 160 watts maximum.
- Fuse size is 2.5 ampere @ 250 VAC, 5 x 20 mm SLO-BLO
- Free air flow for adequate ventilation to the rear of the unit is required.
- Communication between the PP1 and your PC is via 9-pin straight through cable connection to COM 1 and COM 2.
- Analog outputs are available from the DIN screw terminal strips on the rear panel
- The FID drain line must be ¼” inside diameter minimum and without restrictions its entire length.

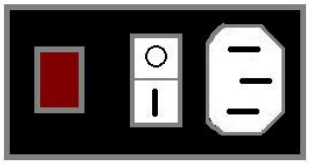
2.3 Electrical Connections

Verify the correct operating voltage as marked on the rear of the analyzer at the main power switch.

Attach a standard power cable to the rear of the instrument (see Figure 1) and connect to an appropriately grounded outlet



Power Cord



PP1 Power Entry

Figure 1. AC Power Connection Details

The PP1 has been CE certified to be immune to AC frequency and voltage variances of +/- 10% of the nominal AC operating voltage. Refer to the final test report and/or markings on the rear of analyzers to verify the proper operating voltage for each unit.

For best stability, power to the analyzer should originate from an electrical circuit free of large inductive or other current loads. Be sure to mount the analyzer in an area of adequate ventilation and make sure the cooling fan inlet is unobstructed.

There are no battery back-ups or reserve power supplies built into the PP1, therefore any disruption of the AC supply will result in restarting of the analyzer. Peak Labs recommends the installation of a high quality on-line or double conversion type of uninterruptible power supply (UPS).

Be sure to mount the analyzer in an area of adequate ventilation and make sure the cooling fan inlet is unobstructed. The operating environment for the PP1 analyzer should be maintained between 15°C and 30°C.

2.4 Rack Mount Specifications

The PP1 is designed for mounting in a standard 19” instrument rack. The analyzer occupies 4U (6.9”) of panel height, 26” in depth.

Rack retaining flanges provided with the Peak rack mount kit attach via the analyzer top cover to provide secure connection to the instrument rack rails.

Peak recommends use of high quality 26” full extension ball bearing slides for instrument mounting, such as Jonathan QD375-26 or equivalent.

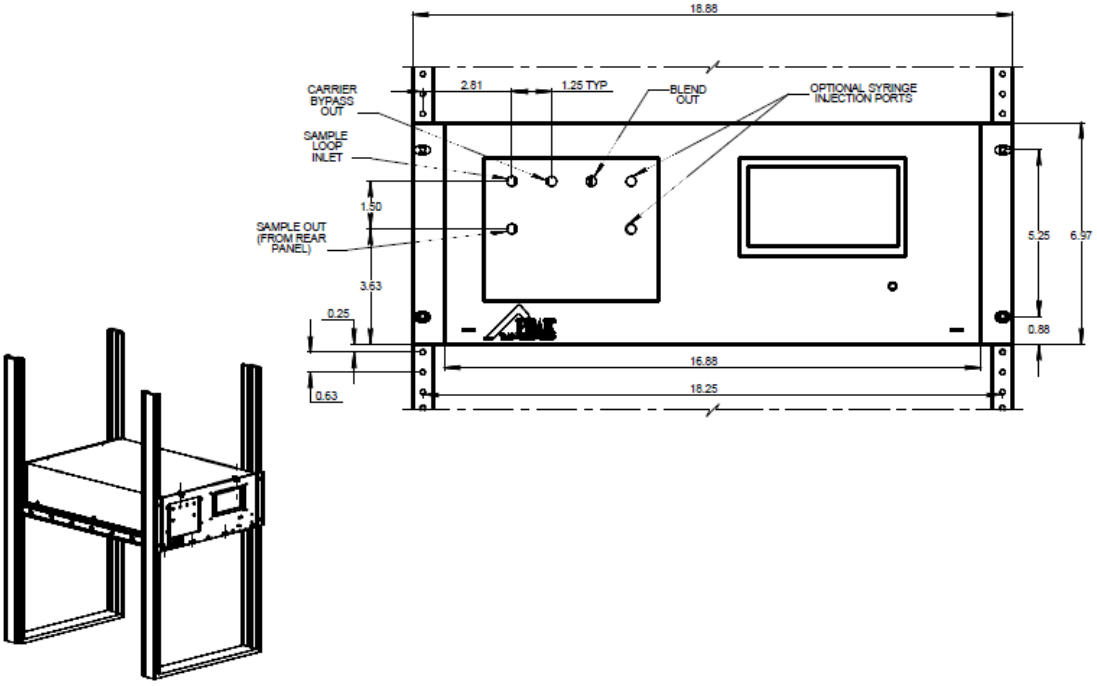


Figure 2. Rack Mount Front View with Dimensions

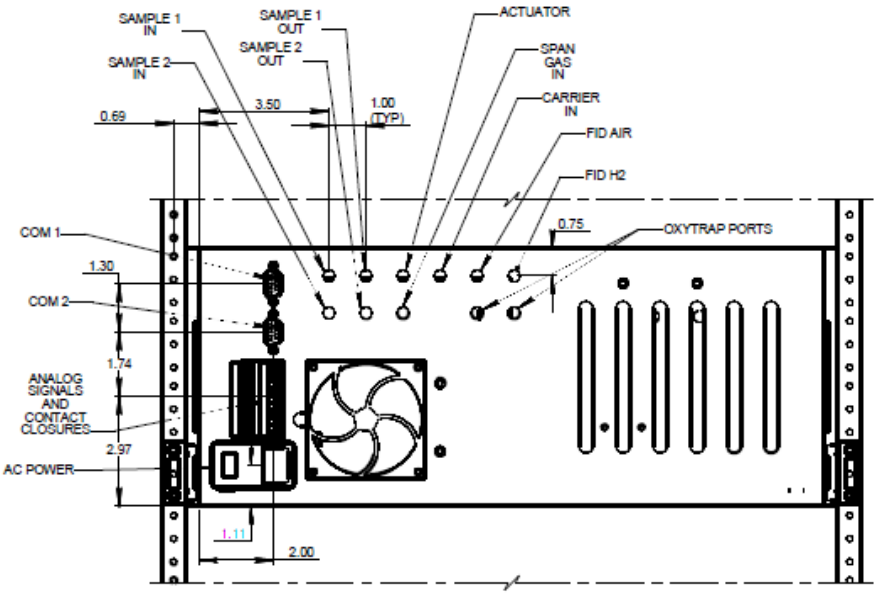


Figure 3. Rack Mount Rear View with Dimensions

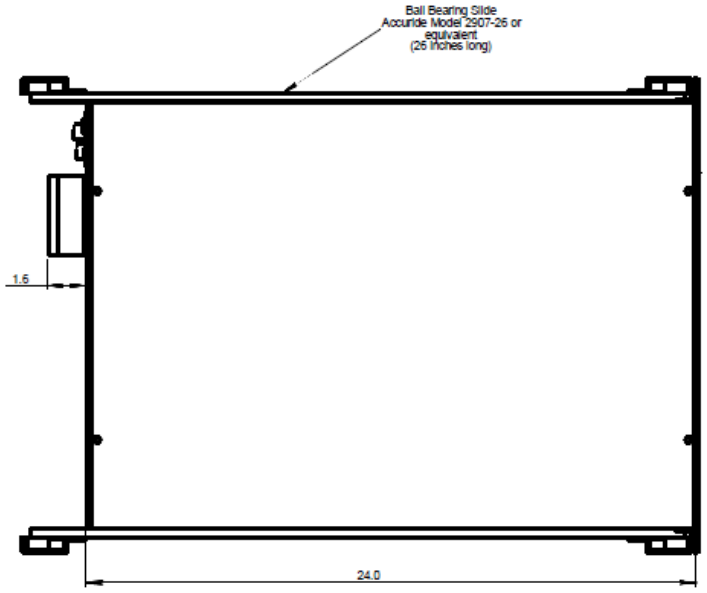


Figure 4. Rack Mount Top View with Dimensions

2.5 Gas Supplies and Connections

All plumbing connections are 1/16” female VICI bulkhead fittings.

The Peak Performer 1 is shipped with tubing and fittings required to connect the analyzer to gas sources.

Replacement materials are available from Peak Laboratories, or may be purchased directly.

a) Standard gas fittings are 1/16” VICI compression fittings (VICI P/N ZN1 & ZF1)
b) Supply tubing is 1/16” O.D x 0.03” I.D, cleaned and baked T300 stainless steel tubing

Figure 5. Rear View of PP1 FID

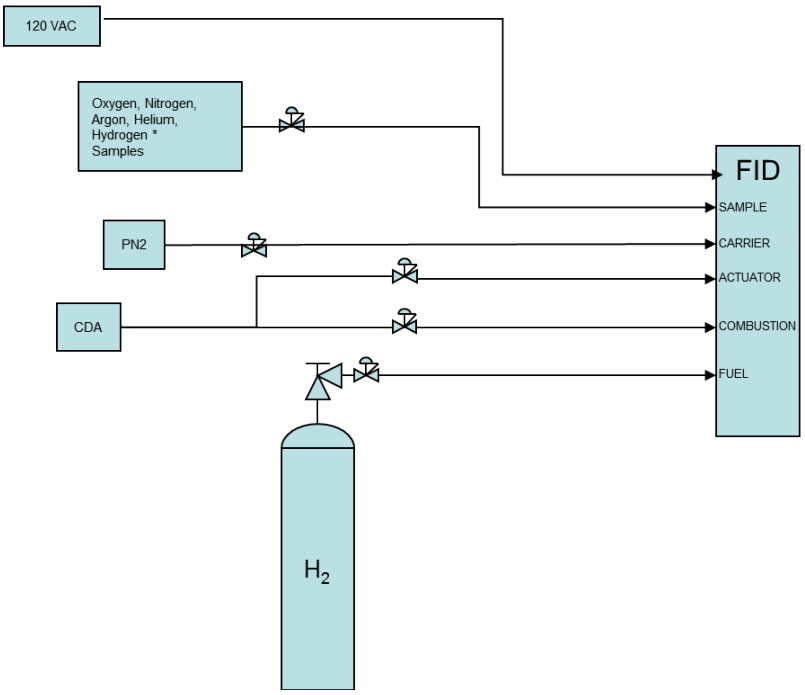


Figure 6. FID PP1 Gas Supply Schematic

2.5.1 Carrier Gas Supply

The instrument will accept a variety of carrier gases: N_2, Ar or He. (See Section 2.5.1.1)

**** CAUTION**:** Oxygen is never a suitable carrier or actuator supply gas. Oxygen is highly reactive, and many pneumatic components contain greases and oils that combust spontaneously when exposed to oxygen.

Consult the test data shipped with the analyzer (in CD format) for carrier gas details specific for your analyzer.

Commonly, the PP1 will utilize highly purified nitrogen as the carrier gas supply, and nitrogen is considered the best multi-purpose carrier gas.

However, the best carrier to use approximates the sample matrix (i.e. nitrogen carrier for analysis of impurities in nitrogen). Matching the carrier gas to the sample will prevent upsets caused by the elution of high concentration sample balance peaks.

For optimum performance, the carrier gas must match the balance gas of your analytical sample, although other carrier gases can be used for specific applications with factory assistance.

PLEASE CONSULT THE TEST DATA ATTACHED TO YOUR ANALYZER IF UNCERTAINTY OF CARRIER GAS SELECTION EXISTS.

2.5.1.1 Carrier Gas Purity

Chromatographic instrument detection limit is directly related to carrier gas purity. Improved carrier gas purity enables improved sensitivity.

Typical Nitrogen 5N Gas Specifications (Pre-Purification)

Source	High Pressure Cylinder or Liquid Dewar
Gas Type	N_2 (Ar, He alternative)
THC Concentration	< 1 ppm
CO, CO_2 Concentration	< 3 ppm
O_2 Concentration	< 3 ppm
H_2, H_2O Concentration	< 3 ppm

Consequently, the analyzer's minimum detectable quantity (MDQ) would be quite high (> 10 ppm) unless the carrier gas is purified.

Peak recommends use of the best quality heated metal getter purifier available for carrier gas purification. This style of purifier typically has a hot catalyst element ahead of the heated getter material for complete removal of methane hydrocarbon (CH_4), a common contaminant in commercial nitrogen sources. Hydrogen, Carbon Monoxide, Carbon Dioxide, Hydrocarbons and Moisture carrier gas impurities are reduced to less than 10 ppt by this type of purifier.

Typical Heated Metallic Getter Purifier Specifications

Type	Heated Reactive Metal Getter
Maximum Flow rate	>300 cc/min, < 5 L/min
Gases Purified	N_2 (Ar, He alternative)
THC Concentration (outlet)	< 1ppb
CO, CO_2 Concentration (outlet)	< 1ppb
H_2, H_2O Concentration (outlet)	< 1ppb
Expected Life	Consult Manufacturer

2.5.1.2 Carrier Gas Purity Requirements

Gas Supply	Gas	Purity	Nominal Pressure	Typical Flow
Carrier	Nitrogen, Argon or Helium	< 1 ppb total contaminants	60 psig	150 sccm
Fuel	UHP Grade Hydrogen	< 10 ppb THC < 1 ppm H2O	25 psig	35 sccm
Combustion Gas	Medical Grade Air	< 10 ppm CH4	20 psig	200 sccm
Actuator	Clean, Dry Air or better	< 10 ppm H2O	70 psig	80 sccm

Heated reactive metal getters are the only proven reliable technique for generating the specified carrier gas purification. Cold metallic getters and absorption getters do not reliably remove all common critical bulk gas contaminants.

2.5.1.3 Carrier Gas Connection

The PP1 carrier gas connection utilizes a 1/16" female VICI bulkhead labeled "CARRIER IN" on the front or rear panel.

1) Connect purified N2 carrier gas supply gas (Ar, He alternative) to the carrier bulkhead and set the source regulator to the settings shown in final test data.

2) There are no internal regulators in the standard FID PP1 – all gas pressures are controlled by external regulators (customer supplied).

3) Verify detector flow with a flow meter to roughly match the settings in the final test data

4) Verify the "BYPASS OUT" port is flowing approximately 25-35 sccm.

Carrier flow within the analyzer is split with a portion of the flow passing through a gas sampling valve, the other portion passes through a restrictor tube terminating at the location of the "BYPASS OUT" port. Under normal operating conditions the "BYPASS OUT" port is plugged.

During column reconditioning, the plug may be removed and the "SAMPLE IN" switched to the bypass flow. In this manner, column reconditioning may be performed without requiring a shutdown of the sample gas flow, avoiding the lengthy re-equilibration period.

2.5.2 FID Hydrogen (H_2) Gas Supply

H_2 venting, H_2 shut-off valve and H_2 supply safety equipment must be supplied by customer.

The analyzer provides a NORMALLY OPEN switch contact for H_2 safety purposes. The analyzer will close the switch contact (CLOSED position) temporarily for 120 seconds any time the IGNITE command in invoked.

If the FID Flame temperature is greater than the set point value, the switch contact will remain closed. Any time the FID Flame temperature is less than the set point value, the switch contact will revert to the NORMALLY OPEN position automatically (see Section 4.7.3)

Combustion fuel must be supplied to the Flame Ionization Detector. The PP1 FID H_2 gas connection utilizes a 1/16" female VICI bulkhead labeled "FID H_2" on the rear panel.

1) Connect the Hydrogen gas supply to the bulkhead and set the source regulator to approximately 25 psig.
2) There are no internal regulators in the standard FID PP1 – all gas pressures are controlled by external regulators (customer supplied),

FID Hydrogen Gas Specifications

Source	High Pressure Cylinder or Hydrogen Generator
Gas Type	Hydrogen
Maximum Flow rate	< 60 cc/min
THC Concentration	< 10 ppm
CO Concentration	< 10 ppm
CO_2 Concentration	< 10 ppm
H_2O Concentration	< 100 ppm

**** CAUTION**** : High moisture content in the FID H_2 gas supply has been shown to irreversibly damage the methanizers ruthenium catalyst.

2.5.2.1 FID H_2 Gas Generators

Peak recommends only the use of “Palladium Transfer Tube” or “Regenerative Drying” Hydrogen Generators.

Hydrogen produced by electrolytic decomposition of water is extremely humid, at nearly 100% relative humidity.

H_2 generators using only single stage gas H_2 dryers (molecular sieves) will saturate with moisture within a week or two of normal use, and therefore require frequent manual exchange and regeneration to maintain acceptable H_2 gas quality

2.5.2.2 FID H_2 Gas Cylinders

Cylinder sources suitable for use as FID H_2 include “UHP” and “Zero Quality” grades.

Gas Supply	Gas	Purity	Nominal Pressure	Typical Flow
Fuel	UHP Grade Hydrogen	< 10 ppb THC < 10 ppm H2O	25 psig	35 sccm

2.5.3 FID Zero Air Gas Supply

Oxygen-bearing gas must be supplied to the Flame Ionization Detector for combustion support.
The PP1 FID Air gas connection utilizes a 1/16” female VICI bulkhead labeled “FID AIR” on the rear panel.

FID Zero Air Gas Specifications

Source	High Pressure Cylinder or Zero Air Generator
Gas Type	79%N_2, 21%O_2
Maximum Flow rate	< 500 cc/min
THC Concentration	< 10 ppm
CO Concentration	< 10 ppm
CO_2 Concentration	< 1000 ppm
H_2, H_2O Concentration	< 100 ppm

Synthetic air sources suitable for use as FID Air include “Zero” and “Breathing Quality” grades.

**** CAUTION****: Compressed room air is not recommended

1) Connect the Zero Air gas supply to the bulkhead and set the source regulator to approximately 20 psig.
2) There are no internal regulators in the standard FID PP1 – all gas pressures are controlled by external regulators (customer supplied),

2.5.4 Actuator Gas Supply

The actuator supply is attached at the rear panel of the instrument. Attach the air or inert gas actuator supply to “ACTUATOR IN” port on the rear panel. Preset the source to 60 - 80 psig.

Gas Supply	Gas	Purity	Nominal Pressure	Typical Flow
Actuator	Clean, Dry Air or better	< 10 ppm H_2O	70 psig	100 sccm

2.5.5 Sample Gas Supply

Sample lines are normally attached to the rear panel of the instrument. Attach sample or span gas lines to the SAMPLE IN port on the rear panel. The SAMPLE OUT port must be unrestricted.

Sample gas must be supplied to the analyzer at low pressure (0.3 to 1.0 psig) and moderate flow (30 to 120 ml/min). The analyzer does not have any sample gas pressure / flow regulation equipment. Higher sample pressures can be used if a fixed restrictor is set and calibrated to the incoming pressure. Please contact the factory for sample handling instructions if these input conditions are not available.

SAMPLE GAS SUPPLY

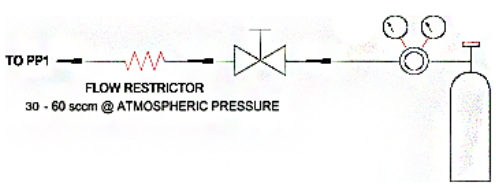


Figure 7. Sample Supply Flow Schematic

2.5.5.1 External Calibration Gas Supply

Certified calibration standards must be connected periodically to the PP1 for verification of analyzer response. When using a mobile calibration gas source such as high pressure cylinder, the plumbing arrangement shown in figure 7 is recommended. The calibration source can be connected to the SAMPLE IN port on the analyzer front panel, or alternatively, make sure the front panel jumper between SAMPLE OUT and SAMPLE IN is installed and connect the calibration source to the rear panel SAMPLE IN port. The SAMPLE OUT port must be unrestricted when using either method.

2.5.5.2 Second Sample Gas Supply

Peak Labs offers an optional second sample inlet stream for most analyzers. Connection to the SAMPLE 1 IN and SAMPLE 2 IN ports should replicate Figure 7.Sample lines are normally attached to the rear panel of the instrument. Attach sample or span gas lines to the SAMPLE IN ports on the rear panel. The SAMPLE OUT ports must be unrestricted.

2.5.6 Calibration Gas Connection for Analyzers Equipped with the Optional Internal Span Gas Blender.

Peak Labs offers an optional internal span gas blender for most analyzers. Connection to the SPAN GAS IN port should replicate Figure 8. Nominal inlet span gas pressure is 50 psig and flow through the internal blender is preset within the analyzer. External restrictors are not required. It is important to measure the pressure applied to the SPAN GAS IN port as closely to the analyzer rear panel as possible.

2.5.6.1 Span Gas Supply (Optional: For internal span gas blender units only)

Peak Labs offers an optional internal span gas blender for most analyzers. Connection to the SPAN GAS IN port should replicate Figure 8. It is important to measure the pressure applied to the SPAN GAS IN port as closely to the analyzer rear panel as possible. Nominal inlet span gas pressure is 50 psig and flow is restricted inside the analyzer. External restrictors are not required for these units

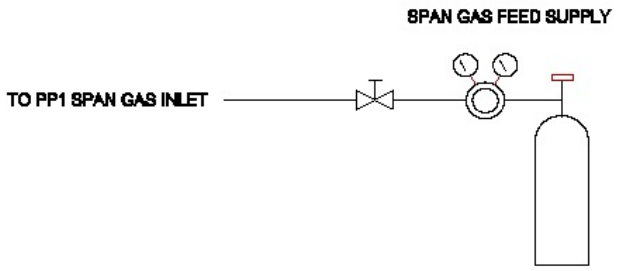


Figure 8. Span Gas Supply Flow Schematic

3.0 Start-up Procedure

Peak Labs recommends that the user read the entire operating manual prior to using the "Quick Start" sequence.

**** CAUTION**** Do not begin detector heating without carrier gas flow. Damage to the detector may result.

3.1 Quick Start Sequence

1. Confirm that all gas connections and supplies are properly made.
2. Remove the top cover of the instrument.

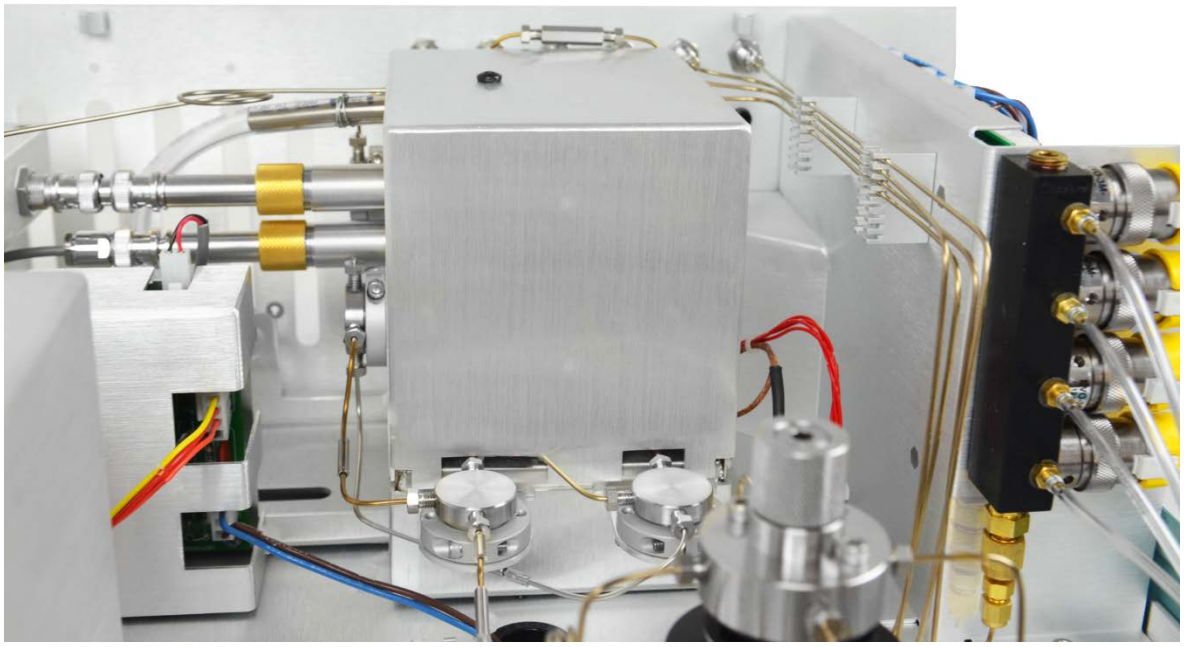


Figure 9. FID Detector

3. Pressurize the carrier gas supply line to 60 psig.
4. Pressurize the FID H2 gas supply to 25 psig.
5. Pressurize the FID Air gas supply to 20 psig.
6. Pressurize the Actuator gas supply to 65 psig
7. Verify that sample is flowing freely through loop - exit flow from the rear SAMPLE OUT port should be 20 to 120 cc/min.
8. Verify "BYPASS OUT" flow > 20 cc/minute.
9. Verify the analyzer is connected to the correct line voltage supply.
10. Energize the main power switch (located to the right of the power cable, see Figure 1).
11. After energizing, the instrument will display the MAIN screen in the IDLE state.

12. Set Date and Time.
13. Press "↓" command three times to position the cursor in the middle 1/3 of the screen.
14. Press the "HEAT" command once to activate heater zones.
15. Allow the 4 –6 hours for the analyzer to thoroughly stabilize the heated zones.

After temperature stabilization:

16. Verify that the FID FLAME reading is greater than 90°C.
17. If the analyzer has been stored or idle without carrier gas flow for more than a few days, consider column conditioning as described in Section 3.2
18. Press the "PAGE" command 4 times to reach the RUN SCREEN.
19. Press the "MANUAL" command once.
20. Press the "IGNITE" command once, wait 30 seconds and press the "IGNITE" command again.
21. Press the "ESC" command once.
22. Press the "PAGE" command once.
23. Verify that the FID FLAME "MEAS" reading is greater than the FID FLAME "SET" reading, if not, repeat steps 18 through 22.
24. Press the "PAGE" command 5 times to reach the RUN SCREEN.
25. If automatic sample cycles are desired, press the "SINGLE" command once to change the setting to "CYCLE".
26. To initiate sampling, press the "RUN" command once. The FID bias voltage will be energized automatically, and the P1 event program will be automatically loaded and run. Cycle samples with "SAMPLE IN" connected to "BYPASS OUT" on the front panel (See Step 17 to start "CYCLE" process)

NOTE: To display concentration data only, press the upper right corner of the RUN screen once – this will hide the chromatogram and display data in large text format. To reveal the chromatogram again, press the upper right corner of the RUN screen again.

27. To halt sampling, press the "IDLE" command once.

3.2 Column Conditioning

Conditions warranting column reconditioning are:

a) Start-up after storage / shipment
b) Reduced detector response,
c) Unstable baseline
d) Merging of peaks.

Normal column operating temperatures are 45° to 90°C. The maximum PP1 FID column operating temperature is 105°C when exposed to oxygen bearing gases.

***** CAUTION ***** Never energize heaters of the instrument unless carrier gas flowing.

***** CAUTION***** The maximum PP1 FID column operating temperature is 105°C when exposed to oxygen bearing gases. Do not exceed 210°C of column oven temperature at any time. Temperatures in excess of 210°C can destroy column material.

1. Connect the front jumper tube between SAMPLE IN and BYPASS OUT.
2. Use the ↑, ↓, ← and → keys to navigate and alter the SET value for the "Column" heater zone to 180° to 200°C.
3. After 8 to 12 hours of stable conditioning temperature, the column temperature may be restored to the original factory setting. (See the Final Test Data shipped with the analyzer)
4. After normal operating temperature is achieved, the front jumper tube may be reconnected between SAMPLE IN and SAMPLE OUT.
5. After a 5-10 minute detector re-equilibration period, samples may be run.

Normal operating temperatures vary with specific application. Consult the Final Test Data for special settings, special reconditioning requirements, etc. for your application.

3.3 Detector Conditioning

**** CAUTION **** The maximum detector operating temperatures for the FID is 350°C.

The FID does not normally require conditioning treatment, however it does require 8 to 12 hours at normal operating temperature to achieve optimum stable performance.

Normal detector operating temperature for the FID is 295°C, although operating temperatures may vary with the specific application.

**** CAUTION **** Do not ignite the flame unless the "FID FLAME" reading is greater than 90°C

See Section 8 for details concerning the effects of operating parameters (temperature and flow) on FID detector performance.

3.4 Igniting the FID Flame

1. Verify that Carrier, FID H2 and FID Air supply pressures and flows match those listed in the final test report.
2. Verify that the FID FLAME temperature is greater than 90C.
3. Press the “PAGE” command 4 times to reach the RUN SCREEN.
4. Press the “MANUAL” command once.
5. Press the “IGNITE” command once, wait 30 seconds and press the “IGNITE” command again.
6. Press the “ESC” command once.
7. Press the “PAGE” command once.
8. Verify that the FID FLAME “MEAS” reading is greater than the FID FLAME “SET” reading, if not, repeat steps 3 through 8.
9. Press the “PAGE” command 4 times to reach the RUN SCREEN.
10. Press the “MANUAL” command once.
11. Press the “BIAS” command once. The screen will display “BIAS –“ to indicate that the bias voltage (-140 VDC) has been turned on.

3.5 Sample Analysis

Verify that sample is flowing freely through loop - exit flow from the rear SAMPLE OUT port should be 30 to 120 cc/min.

Press the “ESC” or “PAGE” commands as needed to navigate to the RUN screen

If multiple sample runs are desired, press the “SINGLE” command to toggle to “CYCLE” (repetitive analysis) mode

Press the “RUN” key to initiate analysis – the P1 event program will be loaded automatically and executed. Allow the analyzer to fully execute the event program. Current concentration data will be displayed as an overlay on the RUN screen as peaks are identified and quantified.

3.6 Calibration

The Peak Performer 1 chromatograph determines concentration peak area to quantify the amount of contaminants in the sample gas. The direct instrument response (in units of uV-sec) is reported simultaneously as an overlay on the RUN / CHROMATOGRAM SCREEN and in the AREA column on the CALIBRATION DATABASE SCREEN.

As the concentration peak area is determined, the analyzer applies the pre-programmed response factor as an inverse proportional factor to generate the reported concentration value.

PEAK CONCENTRATION = PEAK AREA RESPONSE / RESPONSE FACTOR

3.6.1 Establishing New Instrument Response Factors

Connect a known calibration standard gas (span gas) to the analyzer at the SAMPLE IN port on the front panel. (If span gas connection is made at the rear panel SAMPLE IN port, ensure that the front jumper is connected between SAMPLE OUT and SAMPLE IN on the front panel)

Verify that sample is flowing freely through loop - exit flow from the SAMPLE OUT should be 30 to 120 cc/min.

Press the ESC or PAGE keys as needed to navigate to the RUN screen

Press the SINGLE / CYCLE / RERUN key to toggle to SINGLE mode

Press the RUN key to initiate analysis – the P1 event program will be loaded automatically and executed. Allow the analyzer to fully execute the event program. Current concentration data will be displayed as an overlay on the RUN screen as peaks are identified and quantified.

Press the PAGE key as needed to toggle to the CALIBRATION DATA BASE screen

Place the " * " at the first compound of interest and press the EDIT key – use the up, down, left and right arrow keys to enter the span gas concentration in the CONC field. Be certain to use the right arrow key to fully exit the CONC field or all updates will be lost.

With the " * " before the compound name, press the UPDATE key. The analyzer will recalculate the appropriate response factor for the compound based upon the span gas concentration and analyzer area response using the following formula:

RESPONSE FACTOR = AREA RESPONSE / SPAN GAS CONCENTRATION

NOTE: The LED on the analyzer's front panel will change from green to red to remind the user that the current calibration information is stored in volatile (temporary) memory only, and will need to be saved to permanent memory at a later time.

Repeat the sequence for each of the compounds shown on the CALIBRATION DATA BASE screen.

Repeat analysis of the span gas sample and verify that the analyzer reports data values within normal calibration tolerances (i.e. + / - 5%).

3.7 Shutdown and Transport

1. Shut off H2 supply
2. Allow the temperature zones to cool below 50°C (approximately 2 hours).
3. Allow carrier to flow during cool down time.
4. Shut off carrier after cool down time and plug the CARRIER IN, FID H2, FID AIR ports on the rear of the analyzer.
5. Power off analyzer.
6. Cap the SAMPLE IN, SAMPLE OUT and ACTUATOR IN ports.

7. Plug the BYPASS OUT port on the front panel.
8. Ensure that the front jumper tube is connected between SAMPLE IN and SAMPLE OUT.
9. Package the analyzer in a hard cover carrying case or comparable shipping container. If cardboard packaging is used, Peak recommends double boxing of the analyzer using at least 2" of resilient packing material between the inner and outer box walls.

4.0 Peak Performer Operator Interface

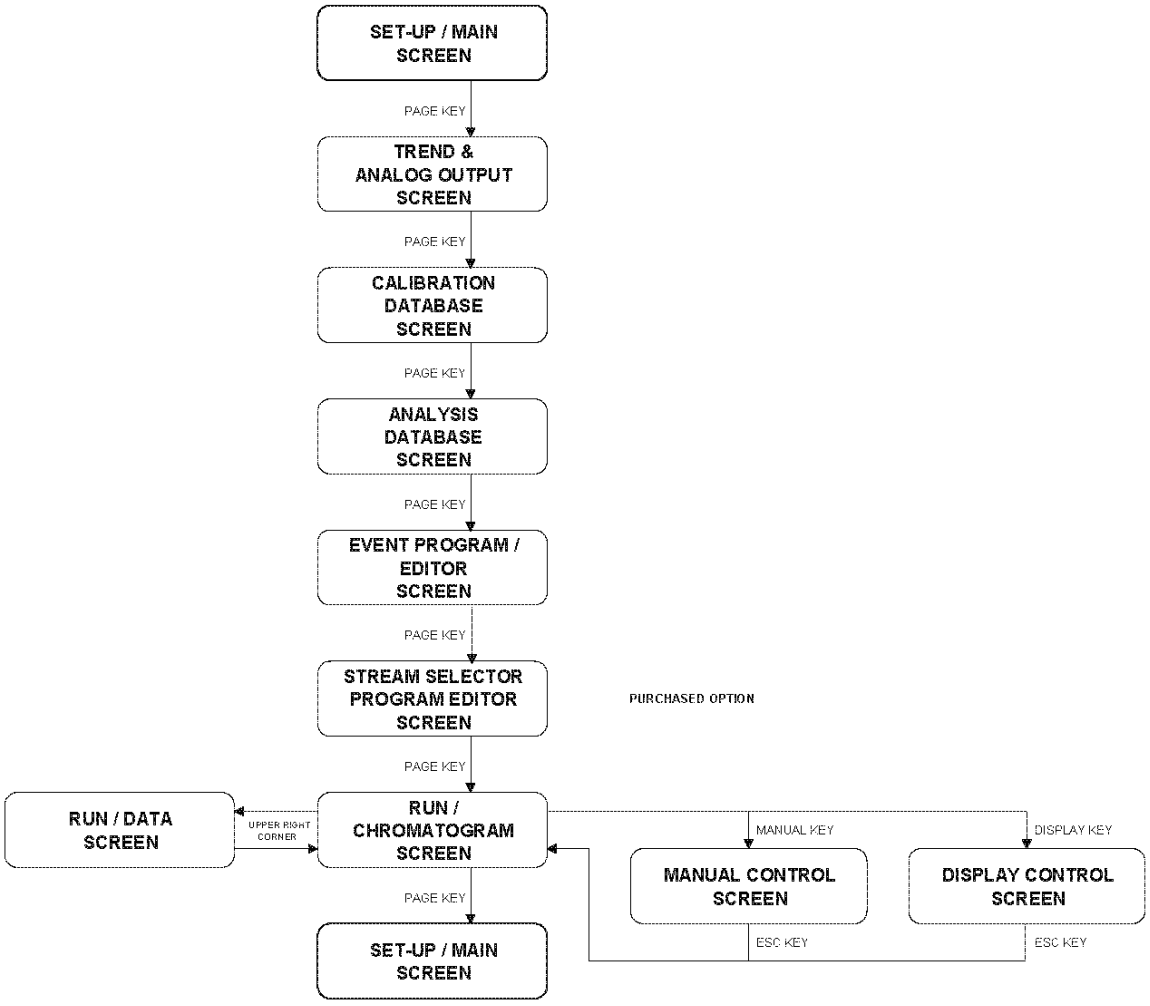


Figure 10. Software Menu Structure

4.1 Set-up Screen

The Set-up screen is multi-functional. Different command buttons appear at the bottom line of the screen dependent upon the section containing the asterick cursor ("*").

1) The upper section (3 lines) contains commands related to analyzer set-up.
2) The middle section (5 lines) contains commands related to temperatures zones and detector parameters.
3) The lower section is reserved for error messages and non-volatile memory updates.

4.1.1 Set-up Screen Upper Section

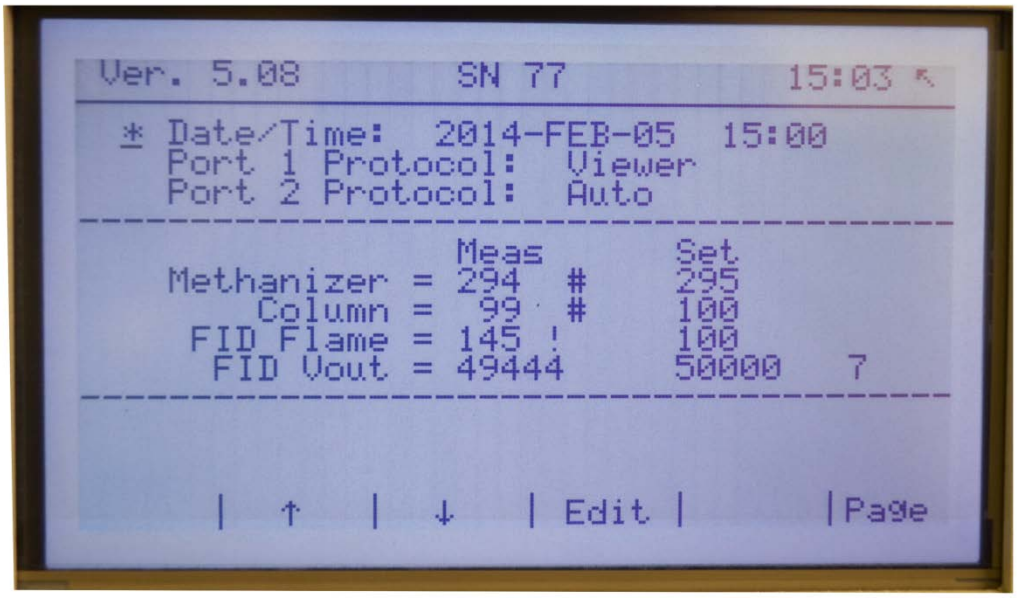

Ver. 5.08 SN 77 15:03
* Date/Time: 2014-FEB-05 15:00
Port 1 Protocol: Viewer
Port 2 Protocol: Auto
Meas Set
Methanizer = 294 # 295
Column = 99 # 100
FID Flame = 145 ! 100
FID Vout = 49444 50000 7
| ↑ | ↓ | Edit | |Page

Figure 11. Main (or Setup) Screen – Upper Section

4.1.1.1 Set-up Screen Upper Section Button Functions

↑ : Moves the cursor "*" upwards.

↓ : Moves the cursor "*" downwards.

Edit: Allows the user to change the Date, Time, or Protocols.

Page: Advances the user to the next screen.

4.1.2 Set-up Screen Middle Section (Power-up)

The middle section of the Setup screen is concerns temperature zone and detector function.

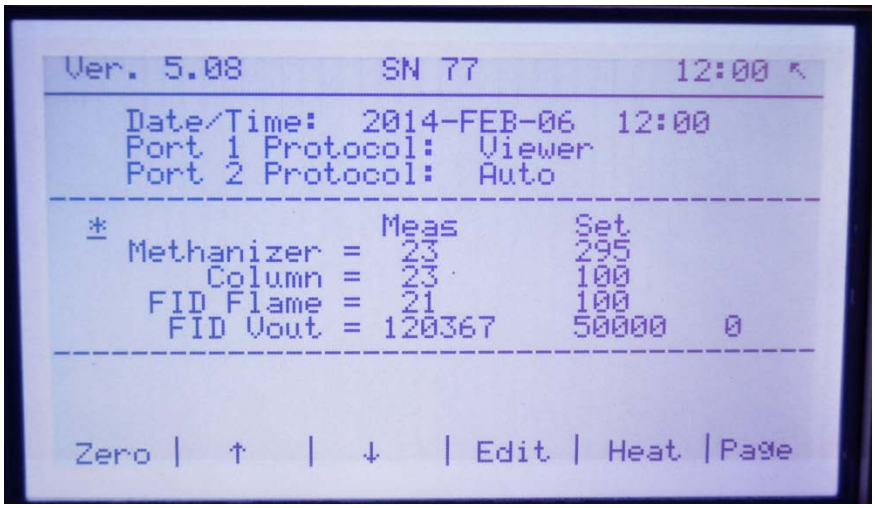

Ver. 5.08 SN 77 12:00
Date/Time: 2014-FEB-06 12:00
Port 1 Protocol: Viewer
Port 2 Protocol: Auto
Meas Set
Methanizer = 23 295
Column = 23 100
FID Flame = 21 100
FID Vout = 120367 50000 0
Zero | ↑ | ↓ | Edit | Heat | Page

Figure 12. Screen Commands Upon Power-up

NOTE: The heater zones are not energized automatically upon power-up, and the detector electronics are not fully initialized until the ZERO command is invoked.

4.1.2.1 Set-up Screen Middle Section Button Functions (Power-up)

If both heater zones are de-energized, the following command buttons are available:

Zero: Allows the initialize the detector electronics and establish a consistent baseline signal.

↑ : Moves the cursor "*" upwards.

↓ : Moves the cursor "*" downwards.

Edit: Allows the user to energize each heater zone or change heater setpoint temperatures.

Heat: Energizes all the heater zones.

Page: Advances the user to the next screen.

4.1.3 Set-up Screen Middle Section (Normal)

The middle section of the Setup screen concerns temperature zone and detector function.

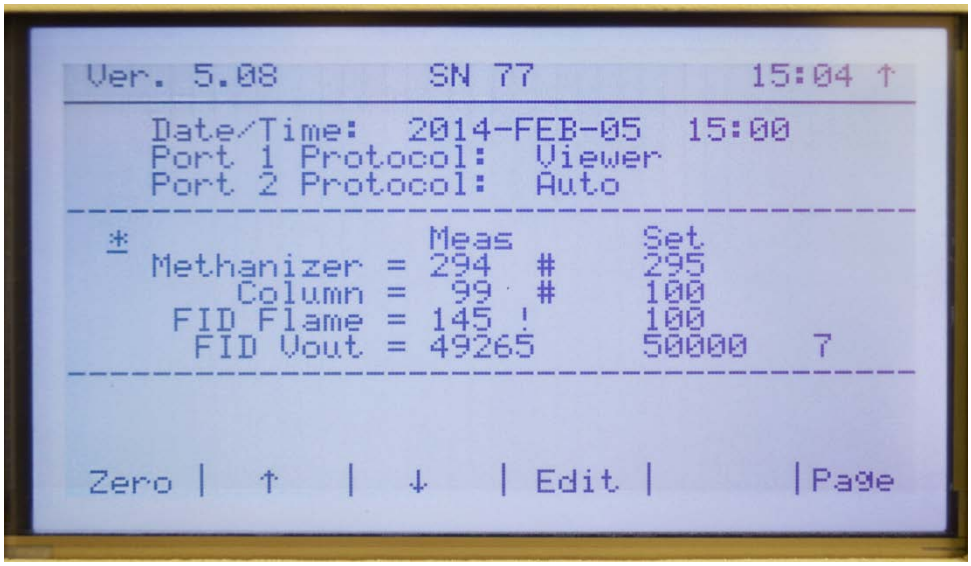

Ver. 5.08 SN 77 15:04
Date/Time: 2014-FEB-05 15:00
Port 1 Protocol: Viewer
Port 2 Protocol: Auto
Meas Set
Methanizer = 294 # 295
Column = 99 # 100
FID Flame = 145 ! 100
FID Vout = 49265 50000 7
Zero | ↑ | ↓ | Edit | | Page

Figure 13. Screen Commands After Warm-up

4.1.3.1 Set-up Screen Middle Section Button Functions (Normal)

Zero: Allows the initialize the detector electronics and establish a consistent baseline signal.

↑ : Moves the cursor "*" upwards.

↓ : Moves the cursor "*" downwards.

Edit: Allows the user to energize / de-energize each heater zone or change heater set point temperatures.

Page: Advances the user to the next screen.

4.1.4 Set-up Screen Lower Section

The lower portion of the Setup screen is reserved for error messages and non-volatile memory updates.

4.1.4.1 Error Messages on the Set-up Screen Lower Section

All error conditions are enunciated by a RED color on front panel LED, and a shift in the ERROR FLAG parameter transmitted through the COM1 and COM2 output ports – see Section 6.1 for additional details.

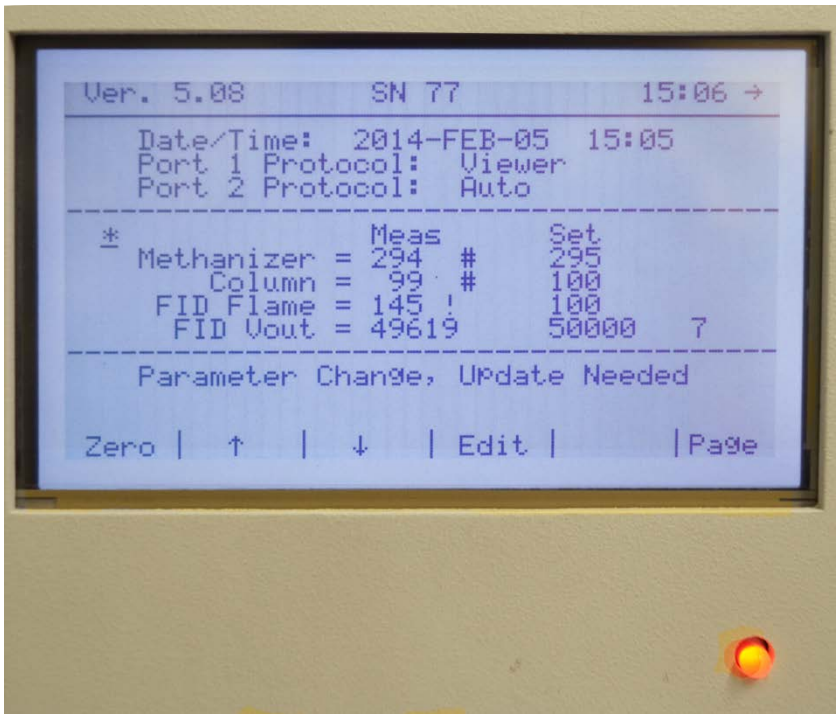

Ver. 5.08 SN 77 15:06
Date/Time: 2014-FEB-05 15:05
Port 1 Protocol: Viewer
Port 2 Protocol: Auto
Meas Set
Methanizer = 294 # 295
Column = 99 # 100
FID Flame = 145 ! 100
FID Vout = 49619 50000 7
Parameter Change, Update Needed
Zero | ↑ | ↓ | Edit | | Page

Figure 14. Set-up Screen Displaying an Error Message

There are eleven individual error conditions that can cause the status LED on the front panel to glow red:

- Detector Communication Error
- Temperature Zone - Out of Range
- Temperature Zone Disabled
- Detector Zeroing Target Error
- Vlamp Low Voltage - Out of Range (RCP Analyzers Only)
- FID Flame Temperature - Out of Range (FID Analyzers Only)
- Event Program Load Error
- Stream Selector Program Error
- Detector Power Disabled
- System Parameters Corrupted
- Parameter Change, Update Needed
- Detector Power Disabled (For PDHID & TCD only)

4.1.4.2 Clearing Error Messages and on the Set-up Screen Lower Section

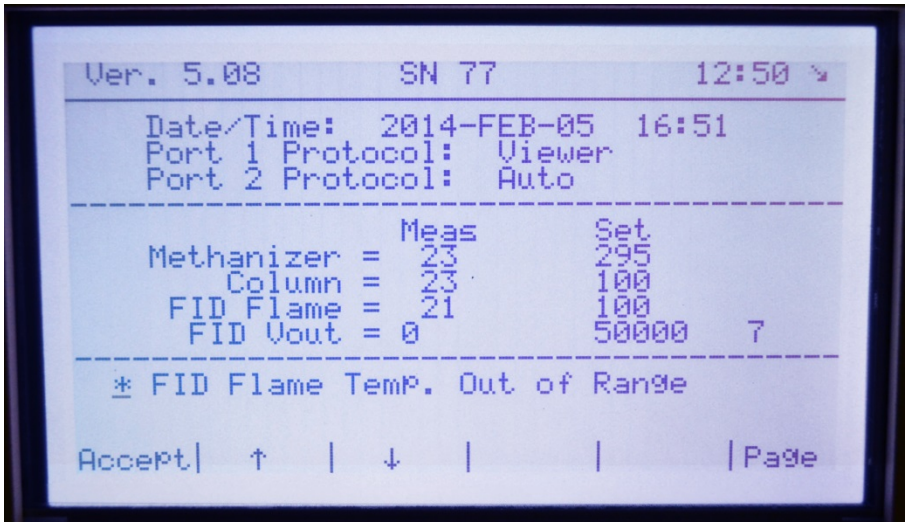

Ver. 5.08 SN 77 12:50
Date/Time: 2014-FEB-05 16:51
Port 1 Protocol: Viewer
Port 2 Protocol: Auto
Meas Set
Methanizer = 23 295
Column = 23 100
FID Flame = 21 100
FID Vout = 0 50000 7
* FID Flame Temp. Out of Range
Accept | ↑ | ↓ | | | Page

Figure 15. Typical FID Flame Out Error Message

All error messages (except PARAMETER UPDATE) can be cleared at any time by pressing the ACCEPT button. However, if the error condition continues to exist, the error message may re-appear.

Accept: Allows the user to acknowledge and clear error messages.

↑ : Moves the cursor "*" upwards.

↓ : Moves the cursor "*" downwards.

Page: Advances the user to the next screen.

4.1.4.2.1 Set-up Screen Lower Section Button Functions

The PARAMETER CHANGE, UPDATE NEEDED error message can only be cleared when the analyzer is not performing an analysis, i.e. is in IDLE mode.

The parameter update action forces a complete re-write of permanent memory and is irreversible.

Peak Labs recommends reviewing all parameter screens before performing a parameter update.

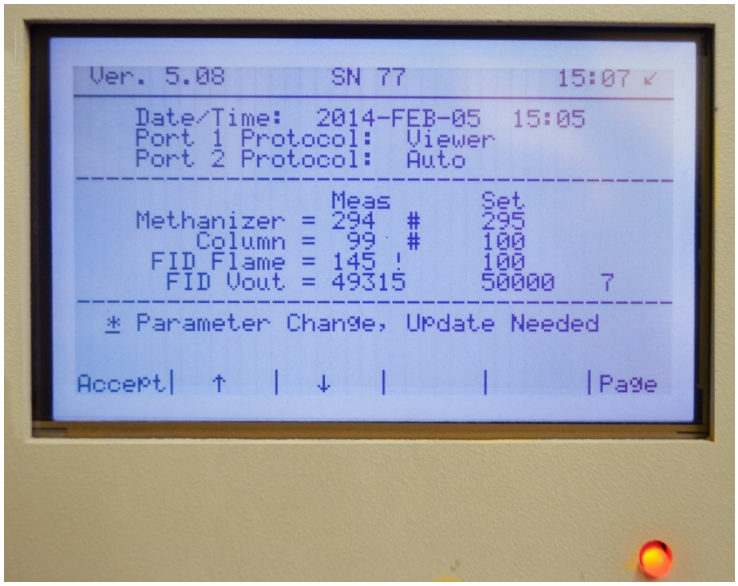

Ver. 5.08 SN 77 15:07
Date/Time: 2014-FEB-05 15:05
Port 1 Protocol: Viewer
Port 2 Protocol: Auto
Meas Set
Methanizer = 294 # 295
Column = 99 # 100
FID Flame = 145 ! 100
FID Vout = 49315 50000 7
* Parameter Change, Update Needed
Accept| ↑ | ↓ | | |Page

Figure 16. Parameter Change Error Message

Accept: Allows the user to initiate permanent updates to non-volatile memory.

↑ : Moves the cursor "*" upwards.

↓ : Moves the cursor "*" downwards.

Page: Advances the user to the next screen.

Pressing the ACCEPT button alters the screen appearance.

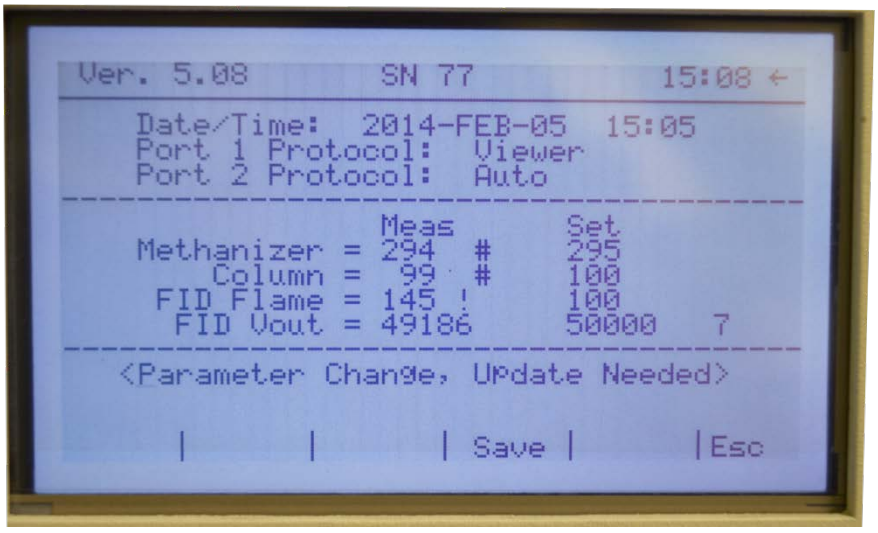

Ver. 5.08 SN 77 15:08
Date/Time: 2014-FEB-05 15:05
Port 1 Protocol: Viewer
Port 2 Protocol: Auto
Meas Set
Methanizer = 294 # 295
Column = 99 # 100
FID Flame = 145 ! 100
FID Vout = 49186 50000 7
<Parameter Change, Update Needed>
| | | Save | |Esc

Figure 17. Parameter Change Prompt

Save: Allows the user to make changes to permanent non-volatile memory.

Esc: Aborts updates to non-volatile memory.

4.2 Analog Interface (Trend and Recorder Output) Screen

The compound (or Channel) information for the ANALOG INTERFACE screen is automatically populated using the information from the ANALYSIS DATABASE screen.

NOTE: The analog outputs are locked if the Port 1 Protocol on the MAIN SCREEN is set to DETECTOR. See Section 4.1.1

Analog signals generated from this information appear on the rear panel's green DIN terminal blocks. See Figure 19.

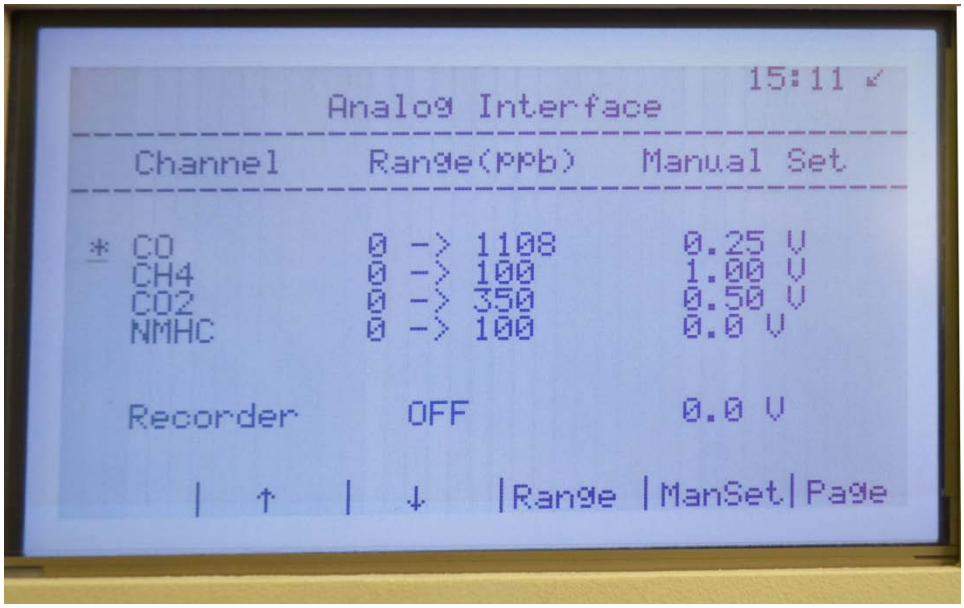


Figure 18. Analog Interface Screen

4.2.1 Analog Interface Screen Button Function

↑ : Moves the cursor "*" upwards.

↓ : Moves the cursor "*" downwards.

Range: Allows the user to select the full scale concentration range associated with the maximum 1.00 VDC signal for each compound. The ranges are user selectable.

e.g. 0 – 1000 ppb readings in the analyzer = 0 – 1.00 VDC output scale.

At the end of each run, the analog signal is updated and holds until the next run is completed. As an accessory, Peak can provide standard commercial VDC -> mA converters as needed.

In lieu of a specific concentrations range, the RANGE button for the recorder function toggles through choices of raw signal attenuation: X1, X2, X4, X8, X16, X64. This function is similar to the RANGE switch on a chart recorder. This function only affects the recorder output not the individual compound trends.

Manset: Temporarily over-rides the signal output with a known output voltage for test purposes.

Four MANSET options are available: 0.00 VDC, 0.25 VDC, 0.5 VDC, and 1 VDC. There is not any zero offset or full voltage scale adjustment within the PP1 – if this function is a requirement, Peak Labs recommends the use of standard commercial voltage converters attached externally to the analyzer.

4.2.2 Analog Interface Connections

All analog interface connections are made via the rear panel DIN connector. To make a proper connection, strip all wires back approx. 3/8", unscrew the terminal locking screw fully, insert the wire and tighten. A common error is insufficient length of bare wire creating the condition where the terminal contacts only the wire insulation

Figure 19. Analog Output Connections

NOTE: The analog outputs are locked if the Port 1 Protocol on the MAIN SCREEN is set to DETECTOR. See Section 6.2 .

4.2.3 Analog Interface Wiring Breakdown

There are 10 total terminal connectors, from the top, the connectors ID's are:

Terminals 1- 6:

- Impurity Trends:

All channels are mapped to the calibration database
All channels are 0 – 1 VDC
All channels signals are updated at the end of run and held
All channels are manually scalable on the "ANALOG INTERFACE SCREEN"
e.g. 0 –> 1000 = 0 to 1000 ppb = 0 – 1 VDC scale. Maximum scale is 999,999
Optional converters to provide other current / voltage outputs are available. Please contact your local Peak representative for additional information.

Terminal 7:

- Analog recorder / raw signal

0 – 1 VDC range

Terminal 8:

- Remote Start Input:

The remote start input is activated by shorting the terminal 8 to COMMON GND for at least 100ms. The remote start input must then return to an open state (unshorten).

Terminal 9:

- FID Flame Switch Relay:

The FID Flame and General Alarm switch relays are SPST- N.O. and rated for 0.5 amps @ 200VDC (10VA)

Terminal 10

- General Alarm Relay:

The FID Flame and General Alarm switch relays are SPST-N.O. and rated 0.5 amps @ 200VDC (10VA)

NOTE: The Analog recorder signal is only active when the COM1 setting is set to "Viewer".

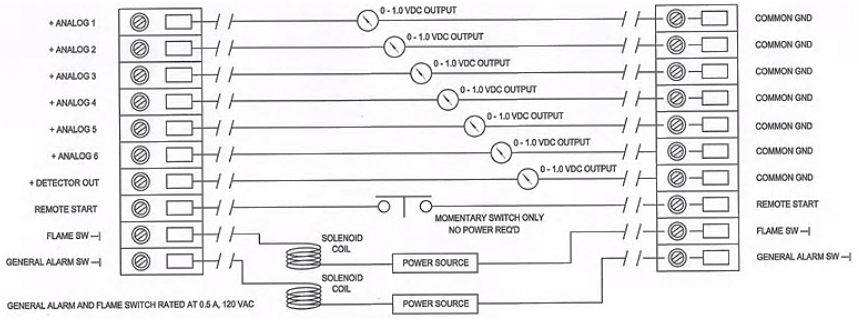


Figure 20. Analog Output Wiring Schematic

Channels 1-7 output voltage can be tested manually by pressing the MANSET key to send a temporary signal for diagnostics.

4.3 Calibration Database Screen

The Calibration Database screen stores critical information regarding calibration (span) gas concentrations and instrument response, and provides tools to easily update the response factors.

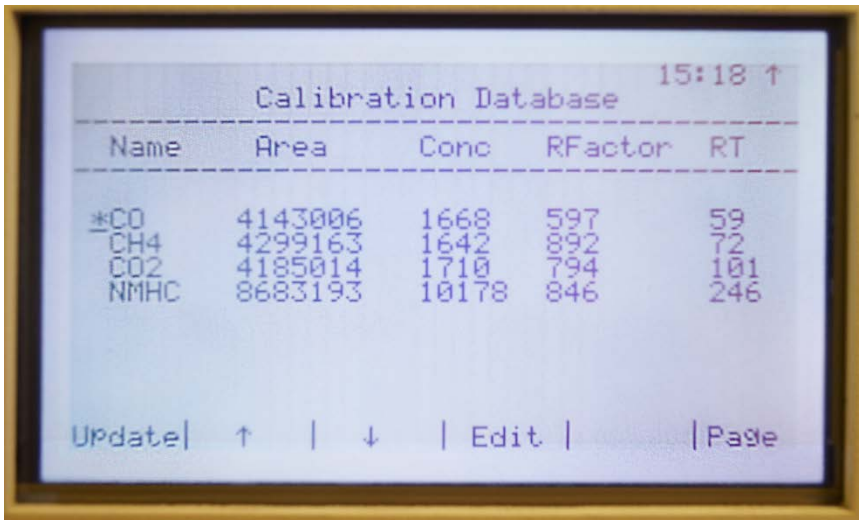


Figure 21. Calibration Database Screen

4.3.1 Calibration Screen Button Function

Update: Allows the analyzer to calculate new RFactor.

↑ : Moves the cursor "*" upwards.

↓ : Moves the cursor "*" downwards.

Edit: Allows the user to change concentration data or response factor.

Page: Advances the user to the next screen.

4.3.2 Calibration

The Peak Performer 1 chromatograph determines concentration peak area to quantify the amount of contaminants in the sample gas. The direct instrument response (in units of uV-sec) is reported simultaneously as an overlay on the RUN / CHROMATOGRAM SCREEN and in the AREA column on the CALIBRATION DATABASE SCREEN.

As the concentration peak area is determined, the analyzer applies the pre-programmed response factor as an inverse proportional factor to generate the reported concentration value.

PEAK CONCENTRATION = PEAK AREA RESPONSE / RESPONSE FACTOR

4.3.2.1 Establishing New Instrument Response Factors

Connect a known calibration standard gas (span gas) to the analyzer at the SAMPLE IN port on the front panel. (If span gas connection is made at the rear panel SAMPLE IN port, ensure that the front jumper is connected between SAMPLE OUT and SAMPLE IN on the front panel)

Verify that sample is flowing freely through loop - exit flow from the SAMPLE OUT should be 30 to 120 cc/min.

Press the ESC or PAGE keys as needed to navigate to the RUN screen

Press the SINGLE / CYCLE / RERUN key to toggle to SINGLE mode

Press the RUN key to initiate analysis – the P1 event program will be loaded automatically and executed. Allow the analyzer to fully execute the event program. Current concentration data will be displayed as an overlay on the RUN screen as peaks are identified and quantified.

Press the PAGE key as needed to toggle to the CALIBRATION DATA BASE screen

Place the " * " at the first compound of interest and press the EDIT key – use the up, down, left and right arrow keys to enter the span gas concentration in the CONC field. Be certain to use the right arrow key to fully exit the CONC field or all updates will be lost.

With the " * " before the compound name, press the UPDATE key. The analyzer will recalculate the appropriate response factor for the compound based upon the span gas concentration and analyzer area response using the following formula:

RESPONSE FACTOR = AREA RESPONSE / SPAN GAS CONCENTRATION

NOTE: The LED on the analyzer's front panel will change from green to red to remind the user that the current calibration information is stored in volatile (temporary) memory only, and will need to be saved to permanent memory at a later time.

Repeat the sequence for each of the compounds shown on the CALIBRATION DATA BASE screen.

Repeat analysis of the span gas sample and verify that the analyzer reports data values within normal calibration tolerances (i.e. + / - 5%).

4.4 Analysis Database Screen

The Analysis Database screen stores critical information regarding peak identification and quantification parameters.

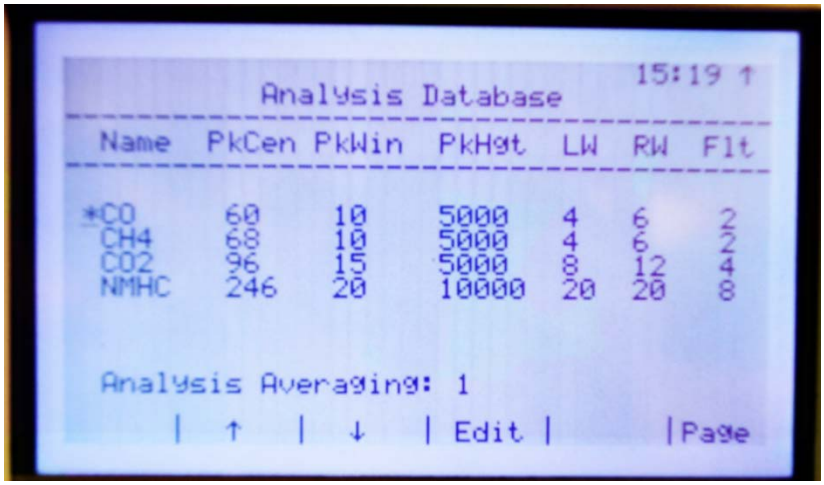

15:19 ↑
Analysis Database
Name PkCen PkWin PkHgt LW RW Flt
*CO 60 10 5000 4 6 2
CH4 68 10 5000 4 6 2
CO2 96 15 5000 8 12 4
NMHC 246 20 10000 20 20 8
Analysis Averaging: 1
| ↑ | ↓ | Edit | |Page

Figure 22. Analysis Database Screen

4.4.1 Analysis Database Parameters

Name = The peak identification tag, expressed as 5 alphanumeric characters (A-Z, 0-9)

PkCen = The normally expected peak retention time (in seconds), used for assigning the appropriate *"Name"*

LW = The typical time span measured from the start of the peak's baseline rise to the peak apex *"PkCen"* (in seconds). Minimum value is 3, maximum is 35

RW = The typical time span measured from the peak's apex *"PkCen"* to the end of the peak's baseline decline (in seconds) Minimum value is 3, maximum is 35

PkWin = Total tolerance window (in seconds) for assignment of a *"Name"* to a quantified chromatographic peak. The tolerance window is centered upon the "*PkCen"* value

PkHgt = A variable for establishing the cross-over point in peak detection modes. Chromatographic peaks higher than this parameter will be quantified using the *"Variable"* mode heights, peaks with height less than or equal to *"PkHgt"* will be quantified using the *"ForceB"* mode.

Flt = The convolution filter value expressing the overall peak shape. Flt = 2 is recommended for sharp, narrow peaks such as H2, and Flt = 8 is recommended for broad peaks such as CO.

As a general rule, LW and RW values do not change significantly with peak concentration, so calibration peak size is not critical in determining proper LW and RW values.

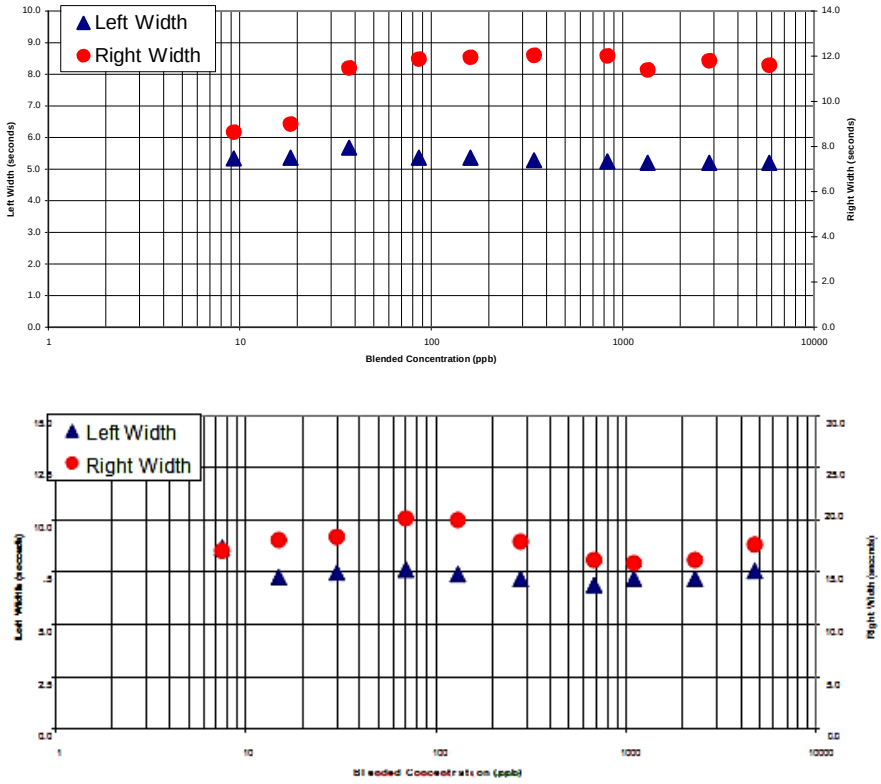


Figure 23. Left and Right Peak Width as a Function of Concentration

- Total peak width (LW + RW) is primarily a function of sample loop unloading.
- Larger sample loops require a long time period to fully inject.
- The relative values of LW and RW are dictated by the skew factor of the peak.
- Peaks need about 25 –30 data points minimum to be well measured - at 5 data points per second, this means total peak width should be greater than 6 seconds.

Therefore, it is recommended to use a substantial calibration peak concentration to facilitate easy LW and RW measurements.

4.4.2 Analysis Screen Button Function

↑ **:** Moves the cursor "*" upwards.

↓ **:** Moves the cursor "*" downwards.

Edit: Allows the user to enter new peak compound name or analysis parameters.

Page: Advances the user to the next screen

Analysis Averaging - When enabled, one, two or four chromatograms are averaged, (data point by data point) to create a composite chromatogram, which is then quantified using normal techniques. Analysis averaging does not average concentration data values.

From analysis start, it will take approximately 30 minutes to obtain the best averaged results.

4.5 Event Program Editor Screen

The Event Program Editor screen stores critical information regarding pre-programmed instrument actions needed to perform an analysis.

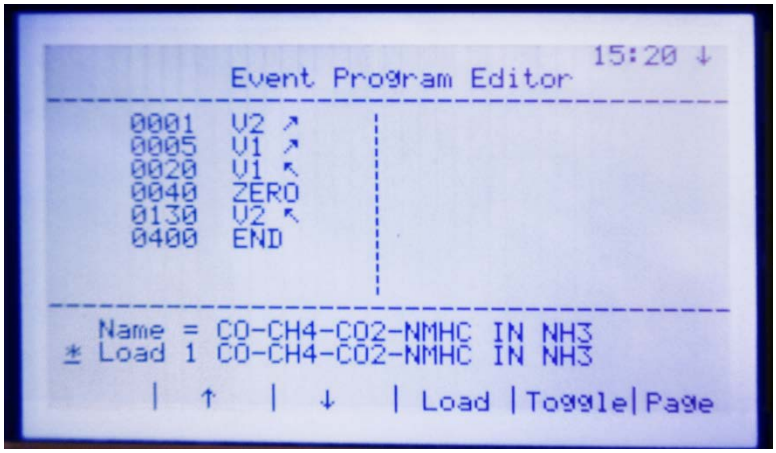


Figure 24: Event Editor Screen

4.5.1 Event Program Commands

The instrument actions can be pre-programmed to create an analysis method or Event Program. The analyzer stores up to 4 distinct Event Programs.

V1／ (CW)	Moves V1 to the Inject position
V1 \ (CCW)	Moves V1 to Load position
V2／ (CW)	Moves V2 to the In-line position
V2 \ (CCW)	Moves V2 to the Vent position
ZERO	Invokes the detector ZERO command
END	Ends the Event Program and prepares the analyzer for the next run
HEAT ON	Not currently in use
HEAT OFF	Not currently in use

4.5.2 Event Editor Screen Button Function

↑ : Moves the cursor "*" upwards.

↓ : Moves the cursor "*" downwards.

Load 1: Allows the user to load the event program # 1.

Toggle: Allows the user to scroll through event program choices.

Page: Advances the user to the next screen

4.6 Stream Selector Program Editor Screen (Purchased Option)

Peak offers a dual sample stream option for most analyzers. The selection and timing of sample streams can be pre-programmed on this screen.

NOTE: This screen will only appear when the STREAM method of analysis is selected on the RUN screen

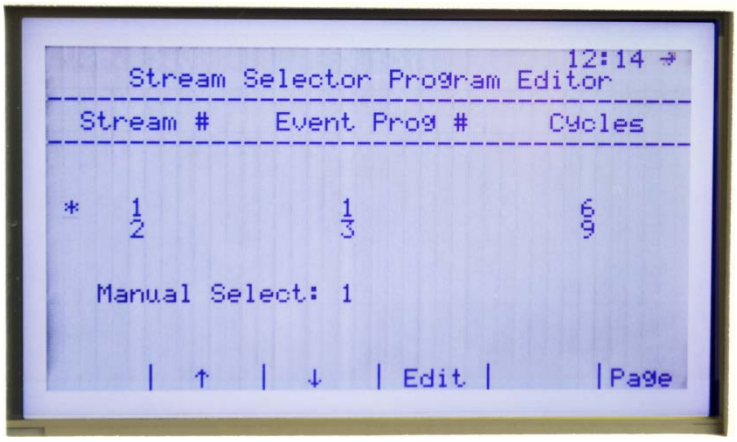


Figure 25. Stream Selector Sequence Screen

4.6.1 Stream Selector Commands

The selection of sample streams and appropriate Event Program can be run in a pre-programmed sequence.

Stream #	Establishes which sample stream to be utilized for analysis
Event Prog #	Establishes which Event Program to be utilized for the sample stream
Cycles	Establishes the number of repeat analysis before switching to other stream

4.6.2 Stream Selector Program Editor Screen Button Function

↑ : Moves the cursor "*" upwards.

↓ : Moves the cursor "*" downwards.

Edit: Allows the user to chose event program # and # of repetitions.

Page: Advances the user to the next screen

4.7 Run / Chromatogram Screen

The Run / Chromatogram screen provides the real time display and data processing of sample analysis. The screen displays the running chromatogram, peak markers, and concentration data. The information displayed on this screen is useful for evaluating instrument health, event program validity, and analytical stability,

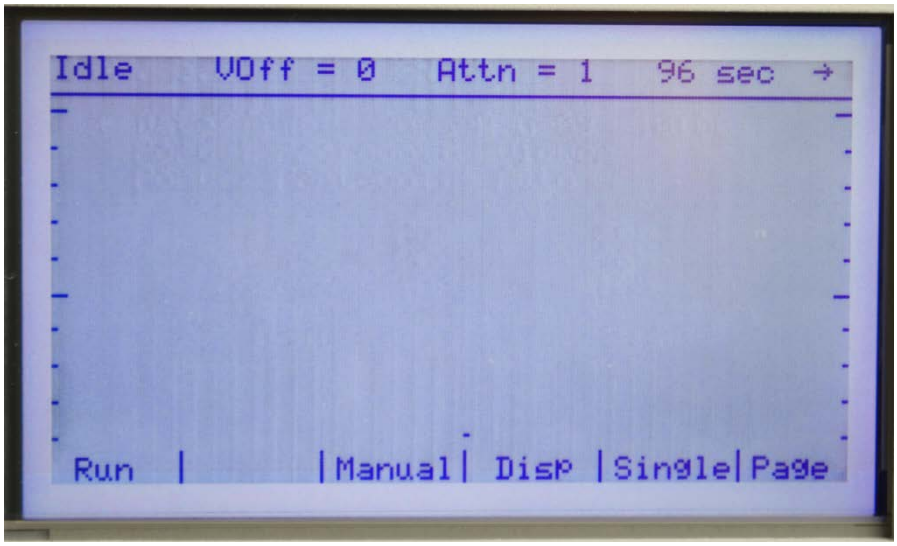


Figure 26. Run / Chromatogram screen in the Idle state, and the mode displayed upon initial power up

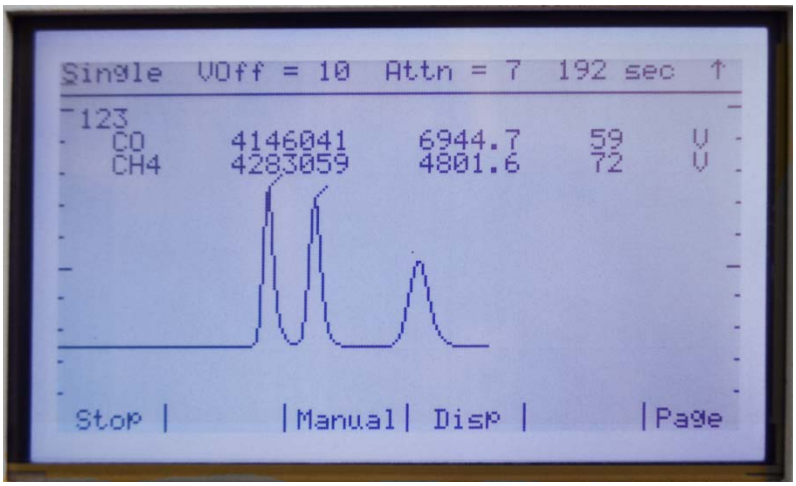


Figure 27. Run screen in Single mode, with chromatogram being drawn

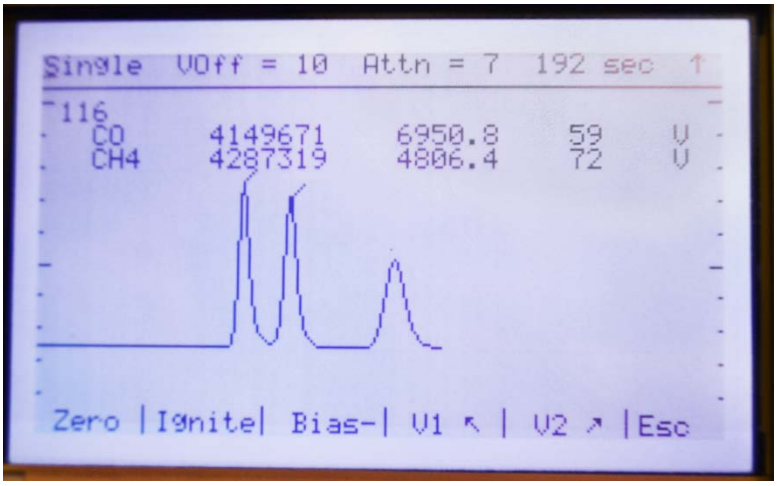


Figure 28. Run screen in Idle mode at end of run

4.7.1 Run Screen Button Functions

Run: Loads a standard event program and runs an analysis in the mode selected.

Idle: Stops the analysis immediately.

Manual: Opens the Manual Run Screen

Disp: Opens the Display Screen

Single: (Toggle). Starting a run in the
will command the PP1 to run one time and return to the idle mode.

Cycle: (Toggle). Starting a run in the Cycle mode will configure the PP1 to run continuously until the Idle key is pressed.

ReRun: (Toggle). Starting a run in the ReRun mode will recompute the area and concentration based on the parameters in the analysis data base.

Stream: (Toggle). Starting a run in the Stream mode will configure the PP1 to initiate the Stream Selector Sequence until the Idle key is pressed.

Page: Advances the user to the next screen.

4.7.2 Continuous Monitoring Analysis

Continuous monitoring is intended for on-line analysis or other applications which ReRun analysis is not required.

Use the “PAGE” key to scroll to reach the Run screen. Toggle the Single / Cycle / ReRun key until Cycle appears. (see Figure 28) Press Run to initiate a repetitive analytical cycle

By pressing the “RUN” key, event program 1 (P1) is automatically loaded and the system will begin to collect data in repetitive mode (see Figure 28).

To halt the cycle, pressing the “IDLE” will cause the analysis run to cease immediately. Toggle between the Single, Cycle, Rerun (or optional Stream) to select the next mode of analysis.

4.7.3 Manual Screen (Sub-Screen of the Run Screen)

The Manual sub-screen allows the operator to invoke all the event program commands on demand.

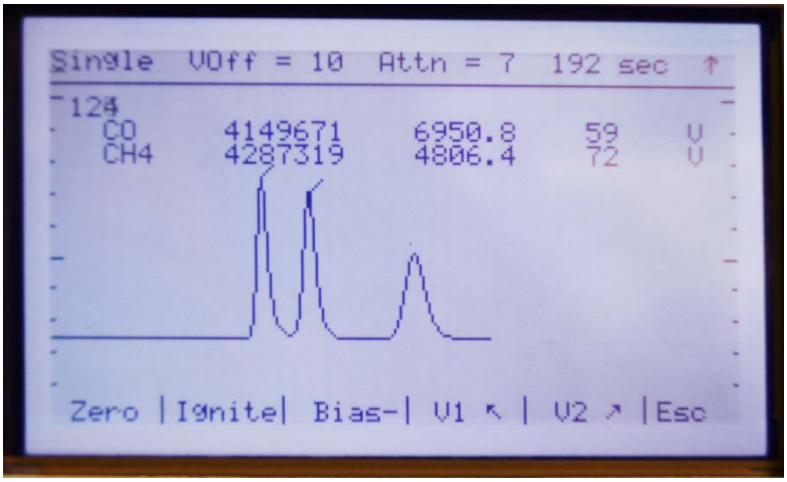


Figure 29. Run / Manual screen

4.7.3.1 Manual Screen Button Functions

Zero: Pressing this key will electronically zero the detector.

Ignite: Pressing this button applies power to the ignition probe for 20 seconds.

Bias: Toggles the negative accelerating voltage within the FID to ON (BIAS-) or OFF.

V1: Toggles Valve 1 between CW and CCW positions.

V2: Toggles Valve 2 between CW and CCW positions.

Esc: Exits from the Manual sub-screen to the Run screen.

4.7.4 Display Screen (Sub-Screen of the Run Screen)

The Display sub-screen allows the operator to adjust the horizontal scale, vertical scale and baseline offset of the chromatogram. These functions mimic those of a standard chart recorder.

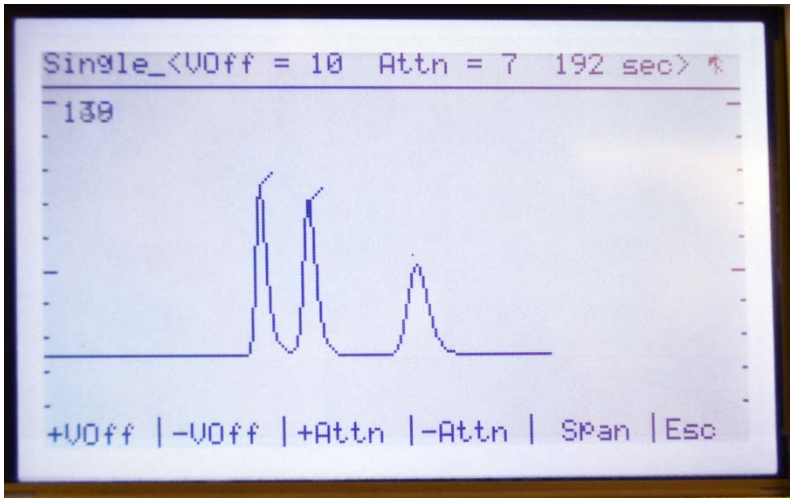


Figure 30. Run / Display screen

4.7.4.1 Display Screen Button Functions

+VOff: Scrolls the screen up (maximum Voff = 11) without changing the scale.

-VOff: Scrolls the screen down (minimum Voff = 0) without changing the scale.

+Attn: Toggles the attenuation / vertical scaling (max. Attn = 11) up.

-Attn: Toggles the attenuation / vertical scaling (min. Attn = 1) down.

Span: Toggles the window view (horizontal scaling) in seconds.

Esc: Exits from the Display sub-screen to the Run screen.

5.0 Peak View Software

The Peak View software has two main capabilities. Primary functions concern acquisition and archiving of compound concentration and acquisition and collection of the chromatogram data.

The software also provides the ability to display and print the data from a remote computer platform.

Peak View software is written specifically for the Peak Laboratories Peak Performer 1 (PP1) gas analyzer covering communications port protocols and data formats and is not intended for use with other manufacturer's analyzers.

5.1 System Requirements

- 1.2 GHz, 20 GB, 256 Mb RAM, 1 USB port
- Windows XP or Windows Vista, Windows 7, Windows 8
- USB to DB9 (RS232) Adapter – Maker: Gigaware Model # 26-949 or equivalent
- DB9 Extension cable, DB9M to DB9F, wired straight-through, 10 feet
  Optional : USB 4 port self-powered Hub – Inland # 08302 or equivalent

5.2 Installing the Peak View Software

1) Place Peak View software CD-ROM disk into CD-ROM drive.
2) If Auto run is enabled, follow the installation screen prompts.
3) If the CD-ROM does not automatically launch, select "SETUP" from CD-ROM disk.
4) The installation software will auto-install the Viewer in a folder under the PC's main drive as the default. The user has options from the installation process to create a new folder and install in a new location.

5.3 Starting the Peak View Software

1) Double-click the Peak View icon on the Desktop or
2) Select "START" button on the bottom Taskbar.
3) Select "PROGRAMS", select "PEAK VIEW ", and double-click to launch move to "Peak View"

5.4 COM1 / COM2 Port and Cable Wiring

The cable connected from the PC to the PP1 should be a straight-through wired 9 pin M/F cable, attached to the PC's COM port and the PP1's COM port. (See Section 6 for details on communications protocols.)

5.5 Viewer Software Window

The Viewer window shown in Figure 33 shows the main Viewer screen **with** a RED DOT in the upper right corner. This RED DOT signifies that there is a connection problem with the PC and the PP1.

Verifying the following can solve this connection problem.

- Communication Settings
- Connection of 9-pin cable between PC and PP1.
- RS-232 cable plugged into the PP1's COM 1 port.
- PP1 is powered off

After the connection problem has found and corrected, the RED DOT should be **CLICKED** to verify if communication between the PC and PP1can be properly established.

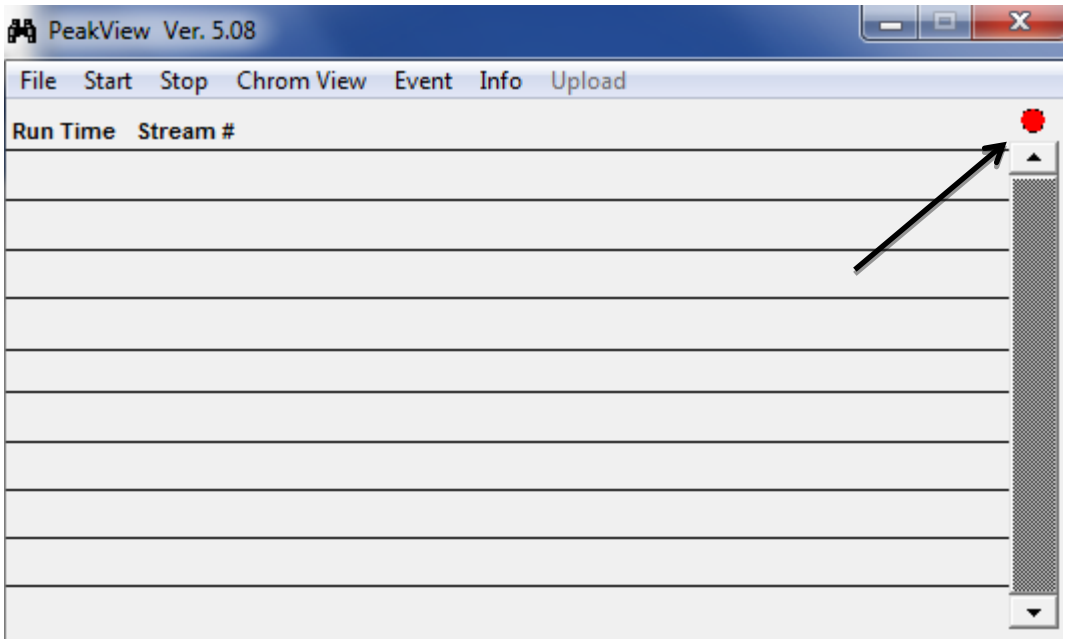


Figure 31. Viewer main window showing Communications Error

The Viewer window shown in Figure 32 shows the viewer screen **without** the RED DOT. This signifies the communication connection between the PC and the PP1 is function correctly.

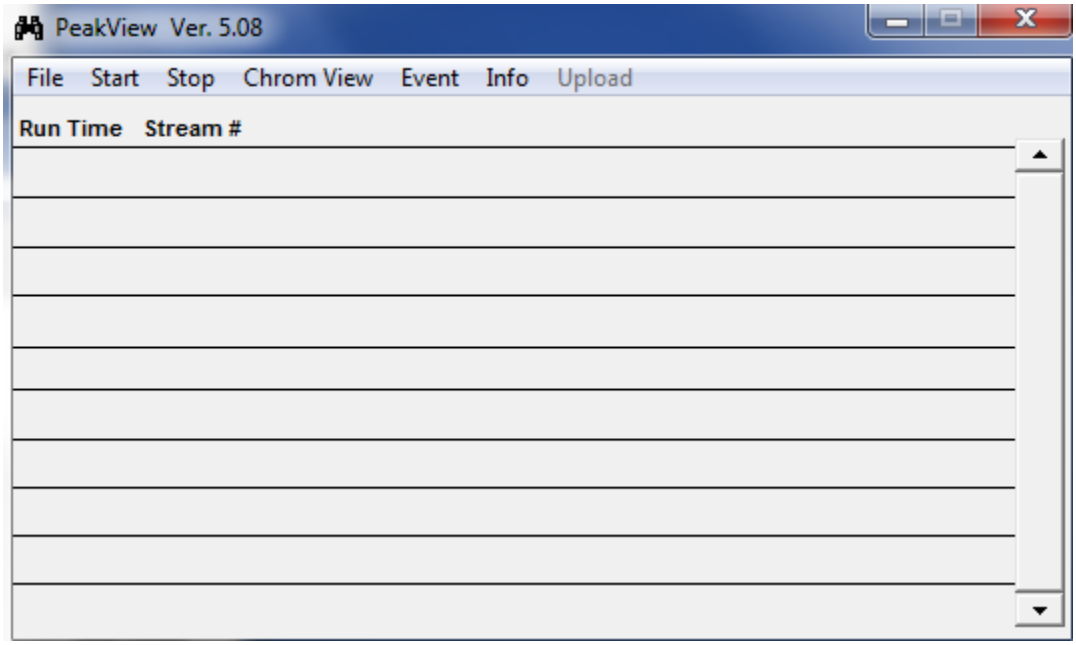


Figure 32. Viewer main window showing no Communications Error

5.5.1 File Menu on the Viewer Taskbar

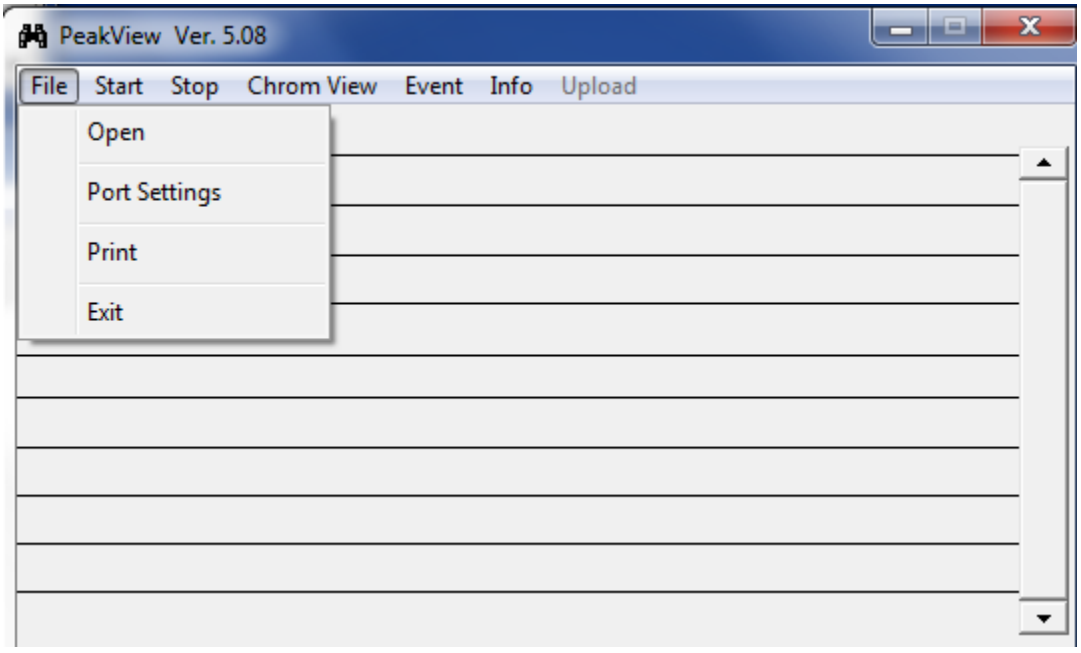


Figure 33. File Menu on the taskbar

The File menu contains the following commands:

Function	Description
Open	Opens a *.CSV file that was created by the Viewer software. Use this command to open a *.CSV file to view the concentration data.
Port Settings	Opens serial communication settings window for setting RS-232 configurations between the Host PC and the PP1. As shown in figure 34. **NOTE** Port number is controlled by host computer and cannot exceed Port# 16**
Print	Prints all concentration data of selected *.CSV file.
Exit	Exit Viewer application.

5.5.1.1 Communication Setting Window

The Communication Settings window is shown in figure 34. This screen displays the serial communication settings used by the PC to communicate to the PP1.

The baud rate, data bits, and stop bits settings should match all of the settings in figure 16, baud rate 38400, data bit 8, stop bit 1.

The COM port number must match the COM port designated by the PC's terminal. The COM Port number is determined by which COM port the serial cable is plugged into on the PC, not the PP1.

Clicking the "OK" button will configure the COM port to the correct options and save the settings in a file on the computer.

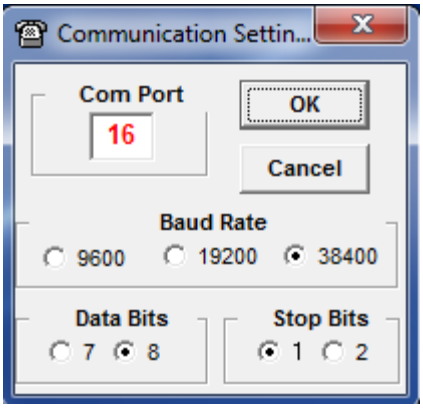
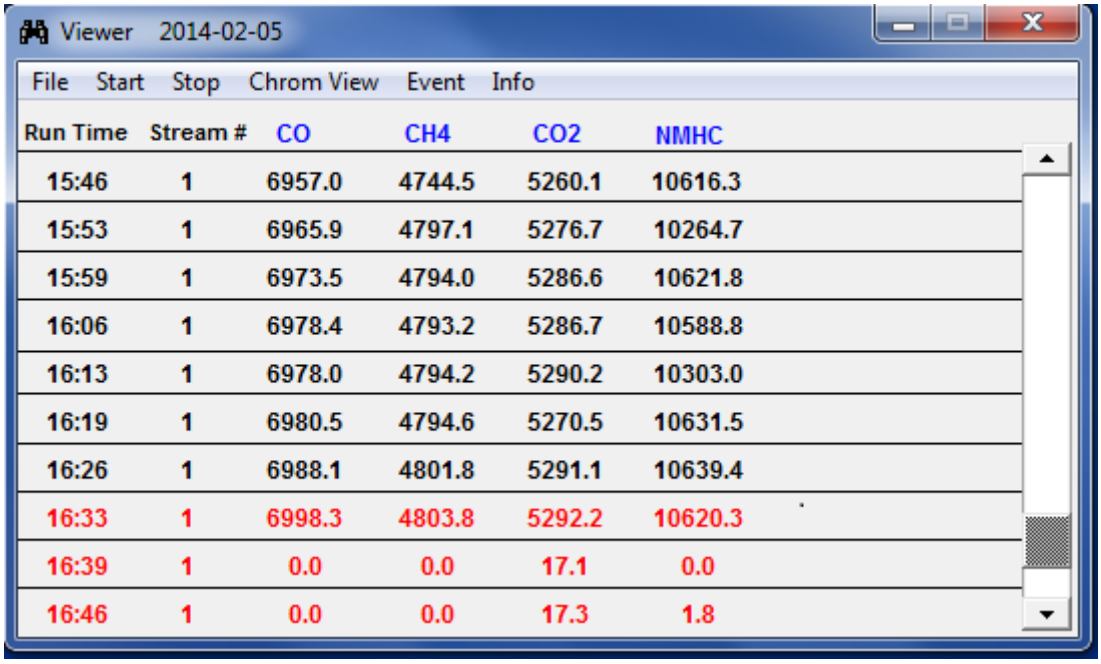


Figure 34. Viewer Software Communications Setting screen

Once the *.CSV file is opened, the Viewer window automatically updates and shows concentration data. Figure 35 is an example with consecutive runs. The run of concentration data at 16:33 is displayed in RED to denote that there was a general error in the PP1 during this run.



Run Time	Stream #	CO	CH4	CO2	NMHC
15:46	1	6957.0	4744.5	5260.1	10616.3
15:53	1	6965.9	4797.1	5276.7	10264.7
15:59	1	6973.5	4794.0	5286.6	10621.8
16:06	1	6978.4	4793.2	5286.7	10588.8
16:13	1	6978.0	4794.2	5290.2	10303.0
16:19	1	6980.5	4794.6	5270.5	10631.5
16:26	1	6988.1	4801.8	5291.1	10639.4
16:33	1	6998.3	4803.8	5292.2	10620.3
16:39	1	0.0	0.0	17.1	0.0
16:46	1	0.0	0.0	17.3	1.8

Figure 35. Viewer screen showing concentration data

There are eleven individual error conditions that can cause the Viewer Line to appear red:

- Detector Communication Error
- Temperature Zone - Out of Range
- Temperature Zone Disabled
- Detector Zeroing Target Error
- Vlamp Low Voltage - Out of Range
- FID Flame Temperature - Out of Range
- Event Program Load Error
- Stream Selector Program Error
- System Parameters Corrupted
- Parameter Change, Update Needed
- Detector Power

5.5.1.2 Viewer Line Details Window

This window is displayed by double clicking on any time-stamp on the Viewer window. The screen provides detailed analytical information about the run selected.

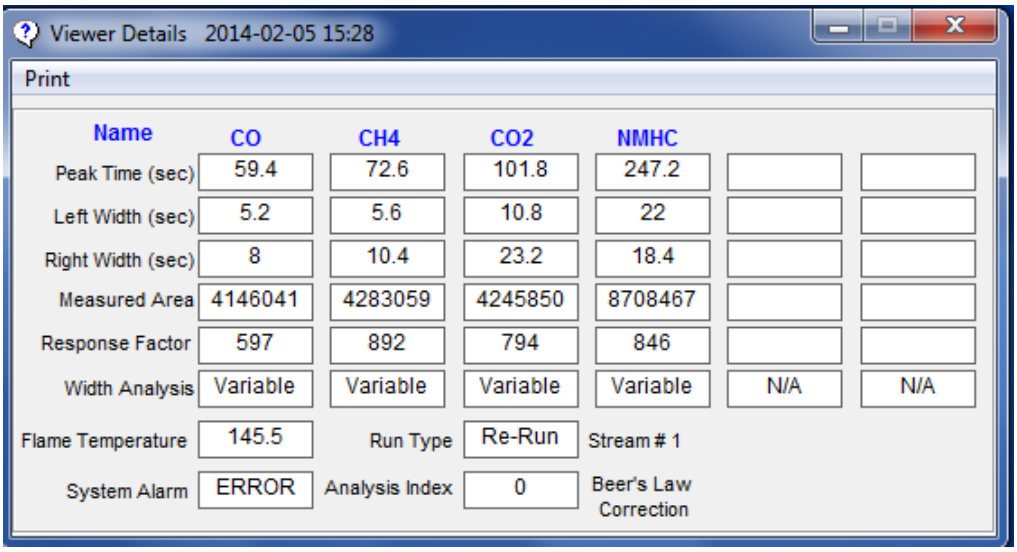


Figure 36. Viewer Detail screen showing raw analysis data.
The information on the screen is linked to run 16:33 displayed in figure 35.

5.5.2 Start Menu on the Viewer Taskbar

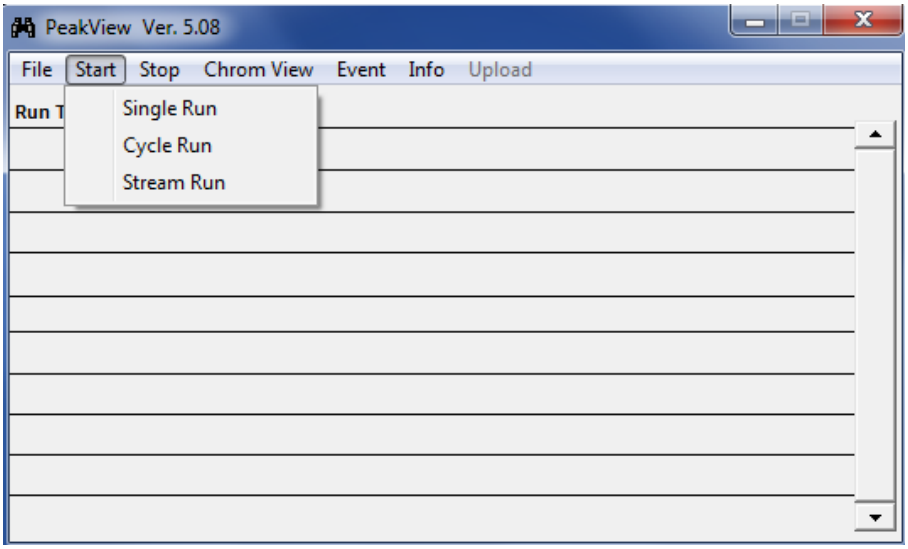


Figure 37 Start menu on the taskbar

The Start menu contains the following commands:

Function	Description
Single Run	Single Run selection commands the PP1 to start a Single Run.
Cycle Run	Cycle Run option commands the PP1 to start a continuous Cycle Run.
Stream Run	Stream Run selection commands the PP1 to start a Stream Selection Run. (This operation only function if the Stream Selection option is installed)

5.5.3 Stop Command on the Viewer Taskbar

The Stop Command selection instantly sends a command the PP1 to terminate the current run immediately.

5.5.4 Chrom View Menu and Chromatograph Viewer Window

The Chrom View menu selection opens the Chromatograph Viewer window. Two methods can open the Chrom Viewer window.

1) The first method is to select the Chrom View menu selection from the Viewer taskbar and then select a ".chm" file to display.

2) The second method of opening the Chrom Viewer is double-clicking one of the concentration values displayed in the Viewer window.

Using either method, after the chromatogram data is loaded, the display can be adjusted by the Offset, Attenuation, and Span scroll bars.

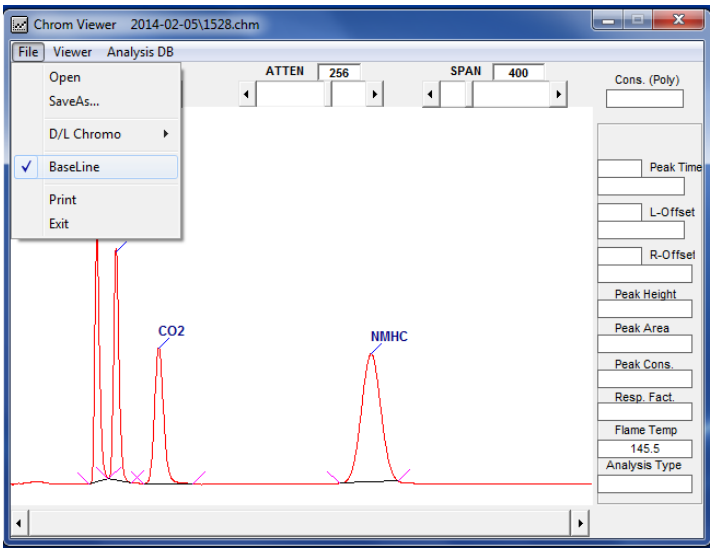


Figure 38. Chromatogram Viewer Window

NOTE: Viewer window scaling does not match the analyzer's display scaling . A higher degree of resolution is available in the Viewer window. For instance, Viewer ATTN 8 approximately is equivalent to analyzer display ATTN 1

5.5.4.1 Chromatogram Files

Chromatograms are archived on the host computer as text files, suffixed ".chm". The text files can be imported into most common laboratory analysis, spreadsheet and word processor programs as needed.

Data points in the chromatogram file are time sequenced at 0.2 seconds per data point.

The filename of the chromatogram file is generated by time of day on the host computer, and the file is stored in a folder that corresponds to the date of collection.

A corresponding Viewer data file is created and / or updated at the time the chromatogram file is created.

As an example, the fourth chromatogram shown in Figure 36 would be archived on the host computer as follows:

Main directory	C:\ Viewer
Sub-directory	2013-12-05 [(YYYY-MM-DD) of archive creation]
Viewer filename	2013-12-05.csv
Filename	0851.chm

5.5.4.2 File Menu on the Chrom Viewer Taskbar

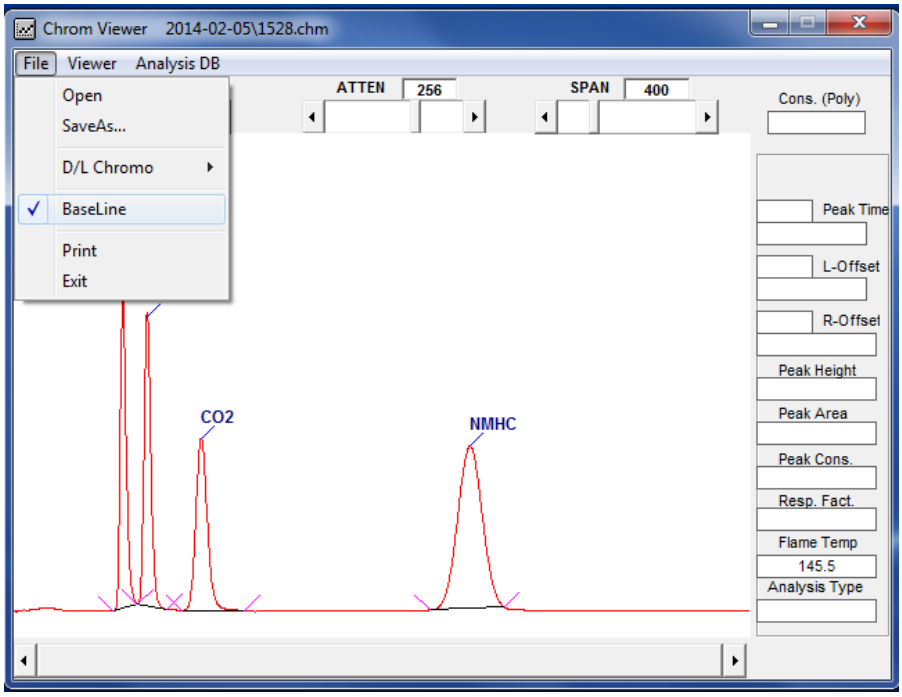


Figure 39. Baseline Selected

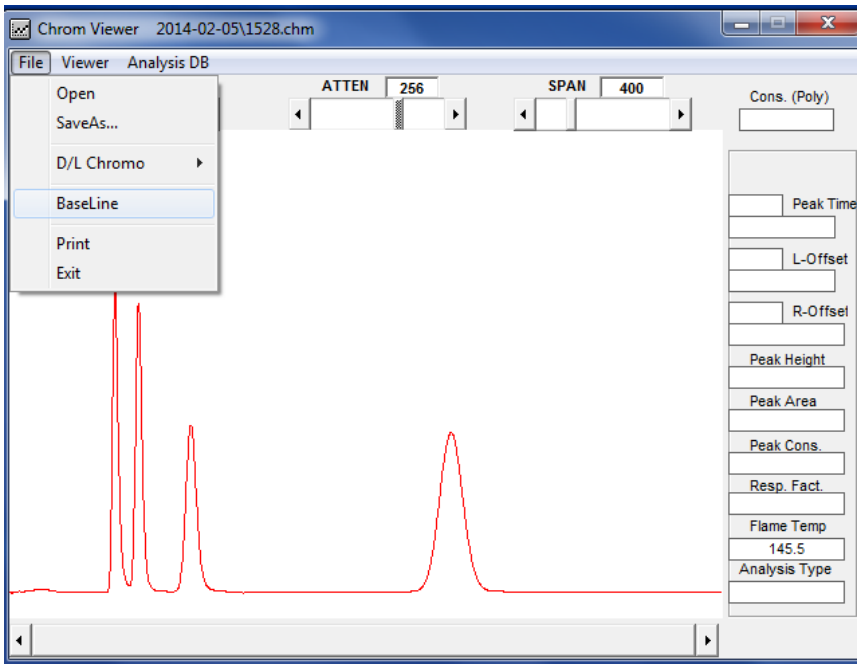


Figure 40. Baseline Deselected

The File menu offers the following commands:

Function	Description
Open	Opens a chromatogram file. Use this command to open and load the chromatogram data for display.
Save As	Save the chromatogram data that is currently displayed.
BaseLine	Enables display of compound name and integration baseline information.
Print	Prints window.
Exit	Exit window.

5.5.4.3 Viewer Menu on the Chrom Viewer Taskbar

The Viewer menu selection returns the user to the original Viewer window. (See Figure 36)

6.0 Communication Port Protocol and Formats

There are two serial communications ports on the rear of the PP1. COM1 is a multifunctional serial port, COM2 port is a dedicated “PLC” output port.

6.1 COM1 / COM2 Port and Cable Wiring

The cable connected from the PC to the PP1 should be a straight-through wired 9 pin M/F cable, attached to the PC’s COM port and the PP1’s COM port.

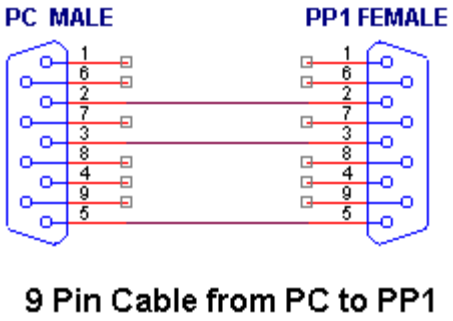


Figure 41. COM Cable Wiring

Peak Labs recommends limiting cable lengths to 25 feet maximum.

6.2 Port 1 Protocol

There are two COM1 output formats: Peak View and Detector. Proper selection of protocol is determined by the application in use on the host computer.

6.2.1 COM 1 Port Settings

The RS-232 settings for COM 1 port are 38400 baud rate, 8 bit data, 1 stop bit, and no parity. These settings are fixed and are not user-selectable.

6.2.2 Peak View Output (Columns Format in .CSV file)

The Peak View software stores information in a common text format, Comma Separated Variable (CSV). CSV files can be opened in common spreadsheet applications for further analysis.

The column format in the *.CSV files are:
A = Data/ Time
B = Run Mode
C = Analysis Buffer Number and Stream Number
D = General Error Alarm
E = RCP Lamp Voltage or FID Flame Temperature
(NOTE: No values to be measured for TCD or PDD and will show up as 0)
F = Compound Name
G = Retention Time
H = Left Point Offset
I = Right Point Offset
J = Area
K = Response Factor
L = Processing Flag- V,F or B

Columns F to L are repeated for M to S, T to Z, and AA to AG for the next five compounds listed in the Calibration Data Base.

6.2.3 Detector Output

The detector output format of the COM1 interface currently supports **one** command from a host computer system. This command remotely starts a RUN.

The PP1 system processes the external start command only if the analyzer is in IDLE mode. (Not running a sample). Upon receipt of the external start command, the PP1 performs the following functions:

- Sets system run mode to SINGLE RUN mode.
- Loads event program P1.
- Starts a Single Run.
- Sends Detector Signal Data stream (i.e. Vout reading) to the COM1 port.
- At the end of the run, the PP1 sends an End-Of-Data string to identify the end of the data stream.
- Sets analyzer to IDLE mode and waits for the next start command.

6.2.3.1 External Start Command String

The External Start Command string format transmitted by host computer must consist of three ASCII characters. Below are four forms of the same command:

Form # 1 Start-Of-Text "S" End-Of-Text
Form # 2 STX "S" EXT

Form # 3 ^B S ^C
Form # 4 02 53 03

6.2.3.2 Detector Signal Data String

The PP1 Detector Signal Data string format is a decimal number followed by a carriage return (CR) and line feed (LF).

An example:

104345
104763
104832
...

The End-Of-Data string format consists of three ASCII characters. The following are four forms of the same command:

Form # 1 Start-Of-Text "E" End-Of-Text
Form # 2 STX "E" EXT
Form # 3 ^B E ^C
Form # 4 02 45 03

An example:

…
104345
104763
104832 // Last sample sent to Host
^BE^C // End-Of-Data command to Host from PP1

6.3 Port 2 Protocol

There are two COM2 protocol formats, PLC (programmable logic controller) and MODBUS protocols. There are three modes of operation: AUTO, POLL, and MODBUS. PLC protocol can operate in 2 modes, AUTO or POLL. The MODBUS Protocol mode is predefined and not user changeable. Proper selection of protocol is determined by the application in use on the host computer.

6.3.1 COM 2 Port Settings

The RS-232 settings for COM 2 port are 9600 baud rate, 8 bit data, 1 stop bit, and no parity for AUTO and POLL modes. The RS-232 settings for COM 2 port in MODBUS mode are 9600 baud rate, 7 bit data, 1 stop bit, and even parity for

Three modes of transmission are available: AUTO or POLL or MODBUS:

- In AUTO mode, the current PLC data string is transmitted at the end of analytical cycle without any request from the host computer.
- In POLL mode, the PP1 will transmit the latest PLC data string only when prompted by the host computer. This mode is recommended for use in a RS-485 network but can also be used for RS-232 connections.
- In MODBUS mode, the PP1 will transmit the latest PLC data string only when prompted by the host computer. See MODBUS uses manual for operational details.

Selecting the POLL mode on the MAIN SCREEN configures the PP1 to wait for a request before transmitting.

The master controller of the RS-485 network must first request data from the PP1 in order for receive the COM2 port output data.
The protocol to request data from the PP1 consists of:

1) A start of transmission character
2) Followed by the unit serial number
3) An end of transmission character.

or

STX character (02 hex)
SSSS
ETX character (03 hex)

The requesting command format follows: **<STX>SSSS<ETX>** , where SSSS = serial number of unit is used as the RS-485 ID.

6.3.2 COM 2 Port PLC Output Format

The COM 2 port output format consists of unit serial number, date and time stamp, error alarm, stream number, followed by impurity data. This data format is transmitted at the end of every run automatically if the COM 2 mode is set to Auto. This format uses a general protocol envelope. This envelope consists of a start of transmission character followed by data, and end of transmission character. The start of transmission indicator is a STX character (02 hex) and the end of transmission indicator is a ETX character (03 hex). The fields within each record are defined as follows:

<STX>SSS,YYYY-MM-DD,HH:MM:SS,E,X,N,AREA,CONC,N,AREA,CONC,…..N,AREA,CONC,<ETX>

- SSS = Serial Number of Unit. This is also used as the RS-485 unit ID
- YYYY-MM-DD = Date (2013-12-05)
- HH:MM:SS = Time (12:23:44 = 12 hours 23 minutes 44 seconds)
- E = General Error Alarm (0 = No Error , “1” = Error)
- X = Stream Number
- N = Name of Impurity (x6)
- AREA = Are of Impurity (x6)
- CONC = Concentration of Impurity (x6)

NOTE: The least significant decimal of the concentration resolution represents 0.1 ppb. (CONC reading of “1” represents a 0.1 ppb concentration level)

6.4 Modbus Protocol and Register Map for Peak Laboratories Devices

This section describes the Modbus protocol for Peak Laboratories PP1 analyzer. It is assumed that the reader is familiar with the Modbus protocol and serial communications in general.

The following rules define the protocol for information transfer between a Modbus MASTER device and the Modbus SLAVE. The MASTER initiates and controls all information transfer on the communications channel. A SLAVE device never initiates a communications sequence. All communications activity occurs in the form of “PACKETS.” A packet is a serial string of 7-bit ASCII bytes. All PACKETS transmitted by the MASTER are REQUESTS. All PACKETS transmitted by a SLAVE device are RESPONSES. At most, one SLAVE can respond to a single request from a MASTER. The PP1 does not support broadcast request packets. The PP1 shall only support the ASCII mode Modbus protocol. The PP1 is only a SLAVE device. The PP1 does not conform to all stated requirements according to the “MODBUS Application Protocol Specification v1.1b3” and “MODBUS over Serial Line Specification and Implementation Guide V1.02.

6.4.1 Mode of Transmission

The PP1 only supports the ASCII mode Modbus protocol. The PP1 analyzer requires the serial communications channel to be configured to 9600 bps, 7 data bits, even parity, and one stop bit.

6.4.2 Modbus Packet Structure

Every Modbus packet consists of four fields:

- Slave Address Field
- Function Field
- Data Field
- Error Check Field (LRC Checksum)

Slave Address Field

The slave address field of a Modbus packet is one byte, two ASCII characters, in length and uniquely identifies the slave device involved in the transaction. Valid addresses will be in a range between 1 and 247. A slave device performs the command specified in the packet when it receives a request packet with the slave address field matching its own address. A response packet generated by the slave has the same value in the slave address field.

Function Field

The function field of a Modbus request packet is one byte in length and tells the addressed slave which function to perform. Similarly, the function field of a response packet tells the master what function the addressed slave has just performed. On page 61 lists the Modbus functions supported by the PP1 when acting as slave, please refer to “Table 2: Modbus Functions Supported by the PP1 as Slave”.

Data Field

The data field of a Modbus request is variable length, and depends on the function. This field contains information required by the slave device to perform the command specified in a request packet, or data being passed back by the slave device in a response packet. Data in this field is contained in 16-bit registers. Registers are transmitted in the order of high-order byte first, low-order byte second.

Example:

- A 16-bit register contains the value 62BE Hex, four ASCII characters.
- High order byte = 62 Hex, two ASCII characters
- Low order byte = BE Hex two ASCII characters
- This register is transmitted in the order 6 2 B E, four ASCII characters.
- Error Check Field (LRC Checksum, two ASCII characters)

Error Check Field

In Modbus ASCII mode, an 8-bit Longitudinal Redundancy Check (LRC) algorithm is used to compute the checksum byte. The checksum field enables the receiving device to determine if a packet is corrupted with transmission errors. The sending device calculates the checksum, 8-bit value, based on every byte in the packet, using the LRC algorithm. The calculated value is inserted in the error check field. The receiving device performs the same calculation, without the error check field, on the entire packet it receives. The resulting value is compared to the error check field. Transmission errors are indicated when the calculated checksum does not equal the checksum stored in the incoming packet. The receiving device ignores a bad packet.

To calculate the LRC:

1. Add up all the data bytes in the message (before converting to ASCII and without the initial colon and final CR/LF).
2. Throw away any bits that carry over 8 bits.
3. Make the result negative (by twos complement) to get the LRC byte.
4. Convert from the 8-bit hex value to two ASCII characters.

6.4.3 Packet Communications:

The PP1 analyzer only supports two Modbus functions, Read Holding Registers and Preset Single Register. Function codes 03, 06 respectively.

Modbus Function	ModBus Description	Function Description
03	Read Holding Registers	Fetch the current value in one or more holding registers from the PP1.
06	Preset Single Register	Write a specific values into a single holding register to the PP1.

Table 1: Modbus Functions Supported by the PP1 as a Slave

Function 03: Read Holding Registers:

To read PP1 parameter values, a Master must send the PP1 a Read Holding Registers request packet. The Read Holding Registers request packet specifies a starting

address and the number of 16-bit registers to read. The Modbus registers are numbered from 40001 to 49999. This Modbus numbering corresponds to an address map of 0 to 9998. The PP1 responds with a packet containing the values of the registers in the range defined in the request. See PP1 address map table to verify address range and content.

Read Holding Registers Packet Example:

The next example, the PP1's Modbus slave address is 92 and the master requests to read two parameters from the PP1. These two parameters are requested from Modbus registers 40013 and 40014. In accordance with the Modbus protocol, holding register 40013 is numbered as address 12 when requested.
Slave Address: 92 = 5C (Hex)
Modbus Function: 03 =03 (Hex)
Starting Register: 12 = 000C (Hex)
Num of Register: 02 = 0002 (Hex)
LRC Checksum : -109 = 93 (Hex) = 39 33 (ASCII)

Request Packet: non-shaded background denotes the DATA field of the packet.

Slave Address		Modbus Function		Starting Register (40013)				Num of Registers (2)				LRC Checksum	
5	C	0	3	0	0	0	C	0	0	0	2	9	3

Response Packet:

Slave Address		Modbus Function		Byte Count		Register 1 Address (12)				Register2 Address (13)				LRC Checksum	
5	C	0	3	0	8	4	E	3	8	2	A	6	0	8	9

The Master device receives the above data packet in response to the request packet:
Modbus Register 40013 =4E38(Hex) = 20024
Modbus Register 40014 = 2A60(Hex) = 10848

Function 06: Preset Single Register:

Preset a value into a single holding register. Place specific values into a single holding registers in the PP1. There is only one holding register that can be written to the PP1. See PP1 register map below.

Preset Single Register Packet Example:

In the next example, the PP1's Modbus slave address is 143 and the master requests to write the value of 3 to Modbus register (40004). In accordance with the Modbus protocol, register 40004 is numbered as address 3 when requested.
Slave Address: 143 = 8F (Hex)
Modbus Function: 06 =06 (Hex)
Starting Register: 3 = 0003 (Hex)

Preset Data: 3 =0002 (Hex)

Request Packet: non-shaded background denotes the DATA field of the packet.

Slave Address		Modbus Function		Starting Register (40004)				Preset Data(3)				LRC Checksum	
8	F	0	6	0	0	0	3	0	0	0	2	6	6

Response Packet:

Slave Address		Modbus Function		Starting Register (40004)				Preset Data(3)				LRC Checksum	
8	F	0	6	0	0	0	3	0	0	0	2	6	6

As you can see from the response packet above, the response is the echo of the requested packet.

6.4.4 Modbus Data Format:

The PP1 is capable of exporting all holding registers into the Modbus protocol. The PP1 data available in a contiguous set of Modbus holding registers. The PP1 output registers are located in the Modbus register map from 40001 to 40099. The actual location is defined in table 3 below.

Six Data Formats Used in the PP1 Analyzer:

- UINT16 - 16 bit unsigned integer 0 to 65,535
- INT16 -16 bit signed integer -32,768 to +32,767
- UINT32 - 32 bit unsigned integer 0 to 4,294,967,295
- INT32 - 32 bit signed integer -2,147,483,648 to +2,147,483,647
- Boolean - Packed Boolean Format
- 8CharString – 8 character string format

16-bit Integer Format:

Unsigned and signed 16 - bit integer formats are the simplest formats. Each PP1 address corresponds to one Modbus Holding Register. If the format is unsigned, the value range for the output registers is 0 to 65535. If the format is signed, the value range is -32767 to +32767.

32-bit Integer Format:

To accommodate values that can reach beyond the 16- bit range, the Modbus Slave provides 32 - bit integer format as an output option. In signed and unsigned 32 - bit integer formats, each PP1 address corresponds to two 16 - bit Modbus Holding Registers. A 32 - bit register represented in 32 - bit integer format is passed via communications as two 16 - bit registers:
High - Order Register = value / 65536
Low - Order Register = value modulus 65536

Example (Unsigned 32-bit):
Value 12345678 is passed in *unsigned* 32-bit integer format:
12345678 = 00BC614E Hex
High Order = 00BCHex
Low Order = 614EHex

Example (Signed 32-bit):
Value -12345678 is passed in *signed* 32-bit integer format:
12345678 = FF439EB2 Hex
High Order = FF43 Hex
Low Order = 9EB2 Hex

Packed Boolean Format:

Boolean registers are packed into a single Modbus register. The boolean outputs corresponds to one bit in the single output register of the module. The relationship is left to right: the first input register corresponds to the left - most bit in the 16 - bit output register, etc.

Example (Packed Boolean Format):
Six Boolean registers are linked to a single Modbus register, which is configured for Packed Boolean output format. If the first three are valued ‘False’, and the remaining three are valued ‘True’, the output register value is:
Register: 0001110000000000 Bin = 1C00 Hex
If the first input register became ‘True’, the output register value changes to:
Register: 1001110000000000 Bin = 9C00 Hex

8CharString Format:

The 8CharString or eight-character-string register format is four 16 - bit Modbus Holding Registers that hold a total of eight ASCII characters.

6.4.5 Broadcast Packets:

The purpose of a broadcast request packet is to allow all slave devices to receive the same request command from the master. A broadcast request packet is the same as a normal request packet, except the slave address field is set to zero (0). All Modbus slave devices receive and execute a broadcast request command, but no device will respond. The PP1 does not support broadcast request packets.

Exception Responses:

If a Modbus master device sends an invalid command to a PP1 or attempts to read an invalid holding register, an exception response is generated. The exception response follows the standard packet format. The high order bit of the function code in an exception response is set to 1. The data field of an exception response contains the exception error code. The table below describes the exception codes supported by the PP1 and the possible causes.

Return Function	Function Description
01	An invalid command is contained in the function field of the request packet. The PP1 only supports Modbus functions 03 and 06.

02	The address referenced in the data field is an invalid address for the specified function. This can also indicate that the registers requested are not within the valid register range of the PP1.
03	The value referenced in the data field is not allowed for the referenced register.
04	The LRC checksum is invalid.

Table 2: Exception Codes supported by the PP1

Exception Response Packet:

Slave Address		Modbus Function		Exception Code		LRC Checksum	
8	F	8	3	0	3	E	B

PP1 Modbus Registers Map:

The PP1 Modbus holding register map defines a set of parameters which are treated as holding registers, having addresses 4XXXX. According to the Modbus protocol, in response to a request for register 4XXXX of a particular slave device, the Modbus master reads register XXXX - 1from the slave. For example, Modbus register 40054 corresponds to holding register 53. There are two classes of Modbus registers within the PP1, Modbus Output Registers, and External Control Registers. See Table 3 below.

PP1 Modbus Holding Registers Map

Modbus Register	PP1 Description	Format	Properties
40001	Unit serial number	UINT16	Read
40002	Main controller software version	UINT16	Read
40003	Detector type (RCP, FID, PDD, TCD)	UINT16	Read
40004	Run Mode(Idle, Single, Cycle, Stream)	UINT16	Read/Write
40005	Run Counter	UINT16	Read
40006	General Alarm Status	UINT16	Read
40007	FID Flame Out Alarm Status	UINT16	Read
40008	Heater Status Zone 1 (On/Off)	UINT16	Read
40009	Heater Set Point Zone 1	UINT16	Read
40010	Heater Temperature Zone 1	UINT16	Read
40011	Heater Status Zone 2 (On/Off)	UINT16	Read
40012	Heat Set Point Zone 2	UINT16	Read
40013	Heater Temperature Zone 2	UINT16	Read
40014-40039	Spare	-	-
40040	Compound #1 Name	8CharString	Read
40044	Compound #1 Area Counts	UINT32	Read
40046	Compound #1 Concentration (PPB/10)	UINT32	Read
40048-40049	Spare	-	-
40050	Compound #2 Name	8CharString	Read
40054	Compound #2 Area Counts	UINT32	Read
40056	Compound #2 Concentration (PPB/10)	UINT32	Read
40058-40059	Spare	-	-
40060	Compound #3 Name	8CharString	Read
40064	Compound #3 Area Counts	UINT32	Read
40066	Compound #3 Concentration (PPB/10)	UINT32	Read
40068-40069	Spare	-	-
40070	Compound #4 Name	8CharString	Read
40074	Compound #4 Area Counts	UINT32	Read
40076	Compound #4 Concentration (PPB/10)	UINT32	Read
40078-40079	Spare	-	-
40080	Compound #5 Name	8CharString	Read
40084	Compound #5 Area Counts	UINT32	Read
40086	Compound #5 Concentration (PPB/10)	UINT32	Read
40088-40089	Spare	-	-
40090	Compound #6 Name	8CharString	Read
40092	Compound #6 Area Counts	UINT32	Read
40096	Compound #6 Concentration (PPB/10)	UINT32	Read
40098-40099	Spare	-	-

Table 3: Modbus Holding Registers Supported by the PP1

6.5 Trend / Analog Outputs

There are seven independent analog outputs on the back of the PP1. The first six are tied to the six impurities as trend outputs and the last channel is a simple recorder output. These trend outputs are provided via 0 – 1.0 VDC screw terminals. Each impurity can be independently scaled by entering the desired range (e.g., 0 –> 1000 = 0 to 1000 ppb = 0 – 1 VDC scale. At the end of each run, the analog trend signal is updated and holds until the end of the next run is completed. As an accessory, Peak can provide standard commercial VDC to mA converters as needed.

6.6 Setting up a RS485 Network

The RS-485 specification supports two-wire half-duplex communications (only one unit may transmit at a time), but allows up to 32 users on a “party line” network.

NOTE: The RS-422 specification supports four-wire full-duplex communications (two units may transmit at a time) and also allows up to 32 users on a “party line” network.

The following information is provided to enable the users to install the Peak Performer 1 into a RS-485 network. This system diagram consists of the PP1, RS-232 to RS-485 converter, and master host controller.

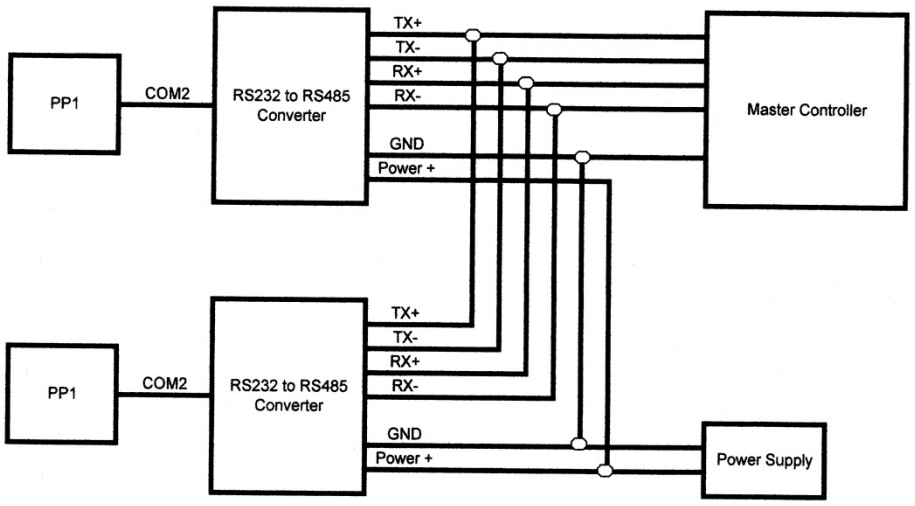


Figure 42. System configuration diagram with basic connections.

6.6.1 RS232 to RS485 Converters

There are numerous manufacturers of RS232 to RS485 converters and the selection of the converter must be determined by the system engineer / designer to meet unique requirements.

7.0 Chromatographic Principles

As an analytical system, the PP1 - FID performs four primary functions:

- Sample injection
- Component separation
- Component analysis
- Integrated microprocessor system control with operator and data interface

7.1 Sample Injection

A standard, air-actuated VICI injection valve is used to inject samples. Standard FID analysis methods use stainless steel 5 cc sample loops.

7.2 Carrier Gas Purification

Chromatographic instrument detection limit is directly related to carrier gas purity. Improved carrier gas purity enables improved sensitivity.

Typical Nitrogen 99.999% Carrier Gas Specifications (Pre-Purification)

Source	High Pressure Cylinder or Liquid Dewar
Gas Type	N_2 (Ar, He alternative)
THC Concentration	< 1 ppm
CO, CO2 Concentration	< 3 ppm
O2 Concentration	< 3 ppm
H2, H2O Concentration	< 3 ppm

Consequently, the analyzer's minimum detectable quantity (MDQ) would be quite high (> 10 ppm) unless the carrier gas is purified.

Peak recommends use of the best quality heated metal getter purifier available for carrier gas purification. This style of purifier typically has a hot catalyst element ahead of the heated getter material for complete removed of methane hydrocarbon (CH4), a common contaminant in commercial nitrogen sources. Hydrogen, Carbon Monoxide, Carbon Dioxide, Hydrocarbons and Moisture carrier gas impurities can be reduced to less than 1 ppb by this type of purifier.

Gas Purifier Specifications

Type	Heated Reactive Metal Getter
Maximum Flowrate	>300 cc/min, < 5 L/min
Gases Purified	N2 (Ar, He alternative)
THC Concentration (outlet)	< 1 ppb
CO, CO_2 Concentration (outlet)	< 1 ppb
H_2, H_2O Concentration (outlet)	< 1 ppb
Expected Life	Consult Manufacturer

7.3 Component Separation

Component separation is normally performed by isothermal packed analytical columns. Column materials vary by application and are noted in the test report documentation. Contact Peak Laboratories for additional details specific to your application.

In general applications, samples are introduced into the instrument through the SAMPLE IN connection. A controlled portion of the sample gas is injected via the pneumatically actuated gas sampling valve into the carrier flow path.

The injected sample passes onto the head of the analytical column(s) inside the isothermal column oven and moves through the analytical column, where the separation of the components begins. The analytes of interest are further refined and methanized on the optional Ruthenium catalyst and continue on to the detector for quantification.

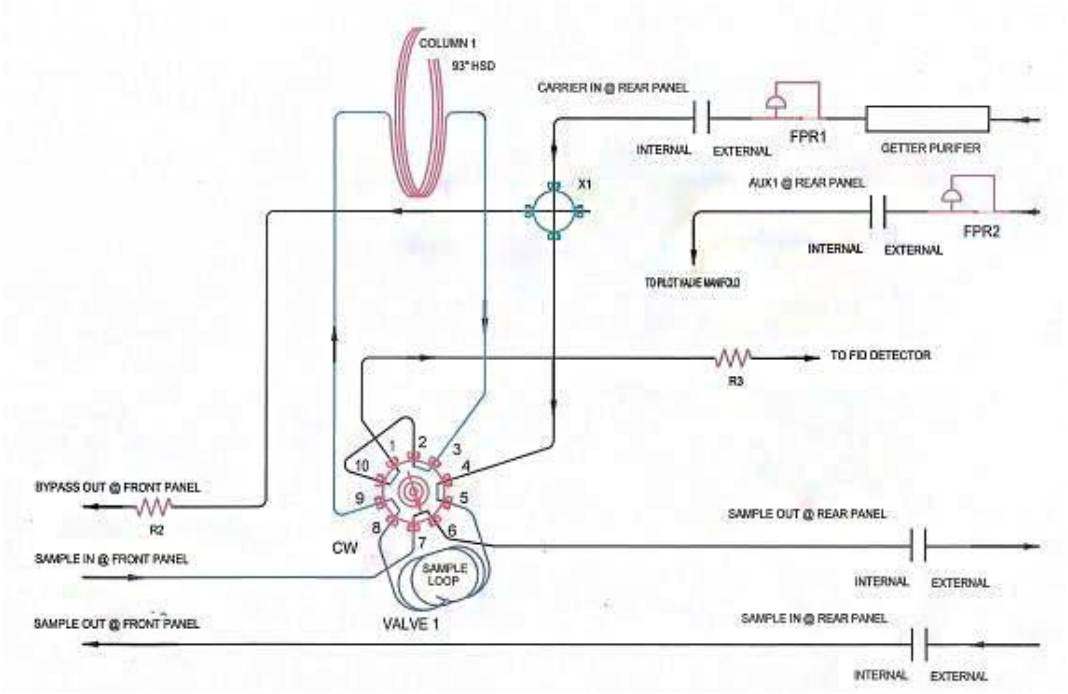


Figure 43. Typical FID plumbing diagram

Immediately after injection, the entire contents of the sample loop are moved to the head of the column(s) and component separation begins.

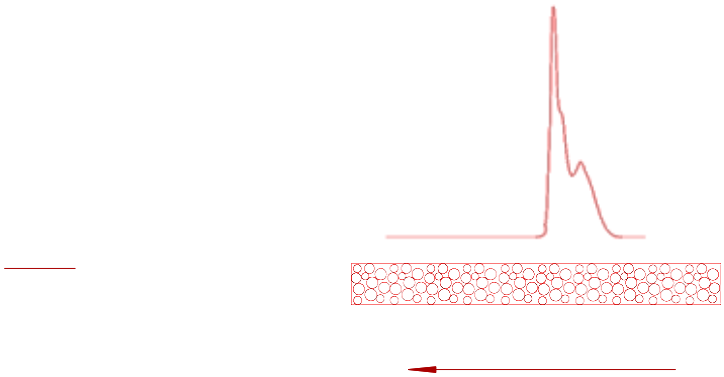


Figure 44. Peak Development on the Analytical Column Soon After Injection

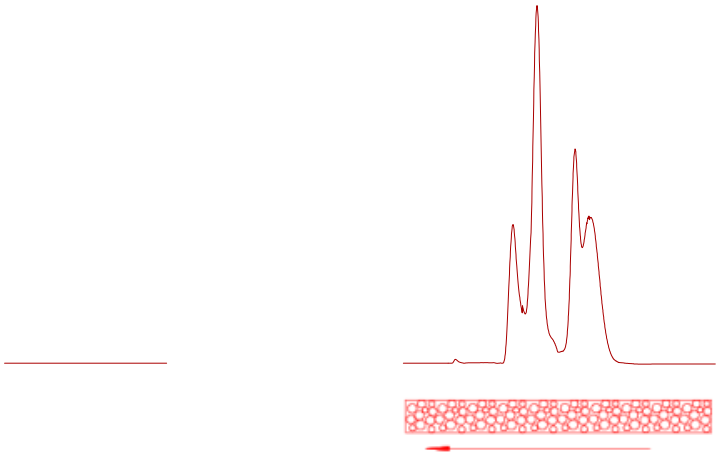


Figure 45. Peak Development Midway on the Analytical Column

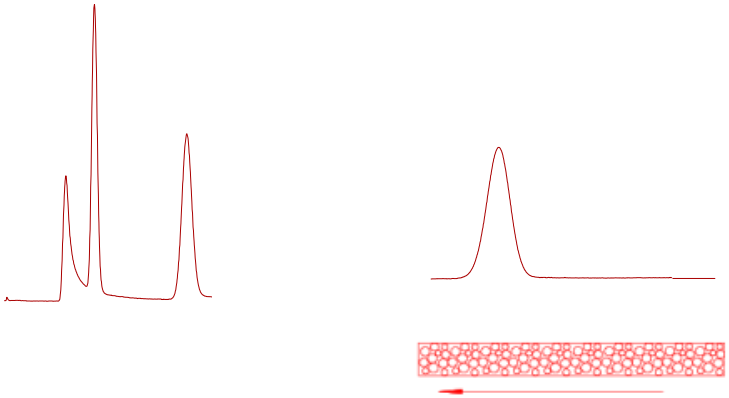


Figure 46. Peak Development Midway on the Analytical Column

Analytes of interest can be allowed to continue on to the detector as long as desired. In some cases, the resulting chromatogram can become quite long in duration. In other circumstances, it is not necessary to quantify all possible peaks, and the remaining balance of the sample is back flushed to vent or detector.

Figure 47. Peak Development on the Analytical Column After Backflush

Figure 48. The Completed Chromatogram

7.4 Flow Venting and Balancing

Several problems can arise in the development of the chromatogram:

- Presence of compounds that may be damaging to the detector
- Disproportionate peak sizes
- Length of analysis

Several models of Peak analyzers are equipped with one or two valve plumbing arrangements to handle these situations. Often a second valve is used to perform "cutting" actions at particular times during the chromatogram, redirecting the column effluent towards a safe flow controlled "vent" outlet.

During the "cutting" action, it is necessary to maintain pure gas flow to the detector. This pure gas flow is provided by an additional branch on the internal carrier gas main line feeding other ports on the valve.

Ultra-high purity flow control components can be bulky and expensive. To diminish installed cost of flow control components, Peak has chosen a different method based upon flow restrictors to create a flow divider. A typical flow divider is shown in Figure 50.

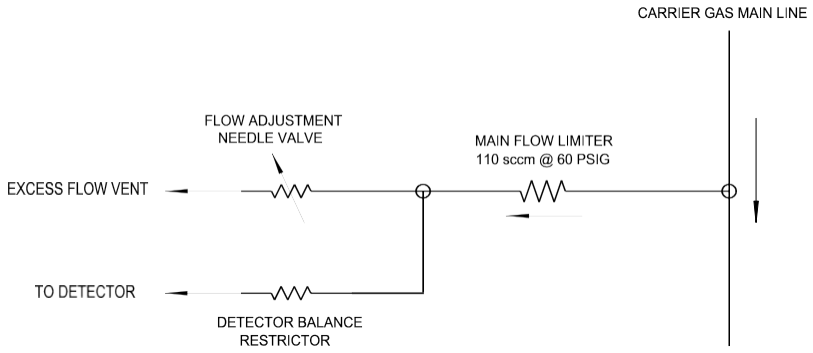


Figure 49. Flow Divider Schematic

The gas flow path to the detector is extremely clean and free of moving parts.

The gas passing from the main flow limiting restrictor can be split to follow both gas paths. Studying the schematic, it can be seen that the detector flow can be adjusted by changing the amount of gas that is allowed to exit via the excess flow vent; as more gas exits the excess flow vent, less gas is available to flow towards the detector.

The controlling needle valves for detector flow rate and column venting are co-mounted in the chassis for convenience. (see Figure 61). The detector flow control needle valve is color-coded red.

Differences in DETECTOR flow during normal and venting valve positions can be expressed as shifts in detector baseline. Careful adjustment of the detector flow control needle valve will enable the operator to minimize baseline drift and create a smooth chromatogram.

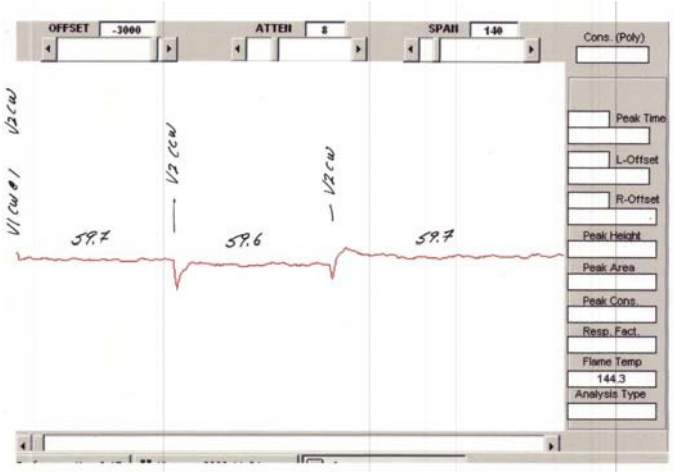


Figure 50. Properly Flow Balanced Detector Baseline

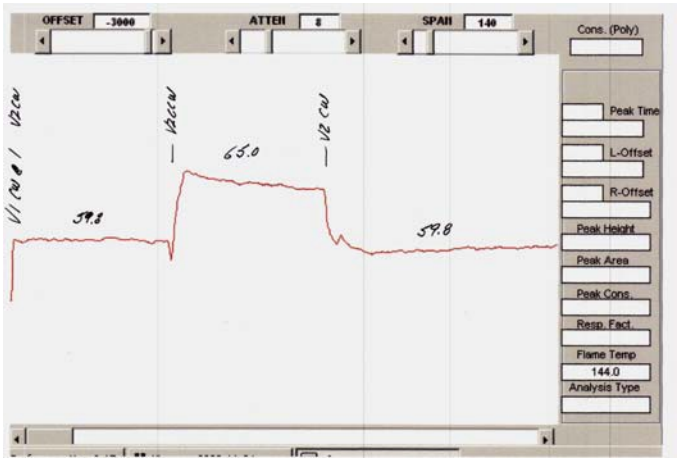


Figure 51. High FID flow from NV1 (note rise after the V2 CCW command)

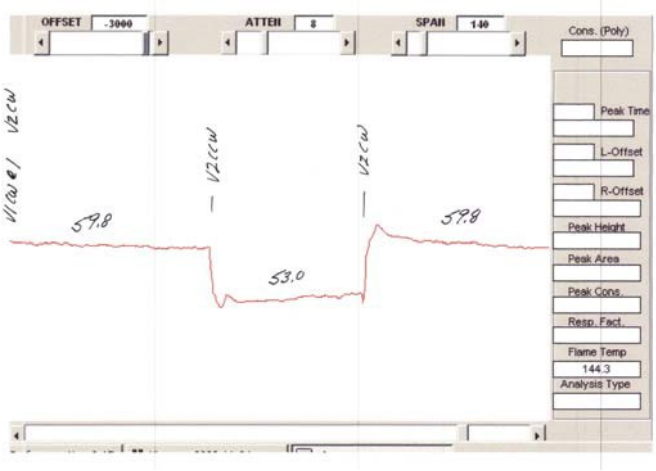


Figure 52. Low FID flow from NV1 (note drop after the V2 CCW command)

Differences in COLUMN flow during normal and venting valve positions will be expressed as shifts in peak retention time compared to a chromatogram without any venting action.

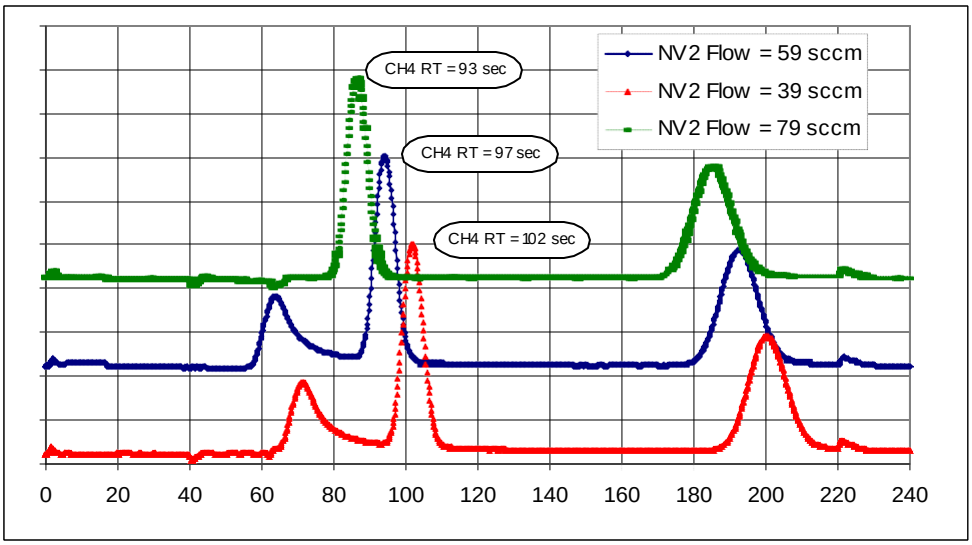


Figure 53. Peak Shifting as a Result of Improper Vent Needle Valve Flow

Comparison of retention times for un-vented versus vented chromatograms will reveal improper adjustment of the vent flow control needle valve.

Careful adjustment of the vent needle valve will enable the operator to minimize peak retention drift and create a consistent chromatogram.

7.5 Effects of Temperature and Flow on Analytical Columns

The normal chromatogram can be affected by changes in column flow and temperature. Be aware that changes of operating parameters from final test conditions can require parametric adjustments (i.e. peak detection parameters, response factors, valve timing) within the analyzer.

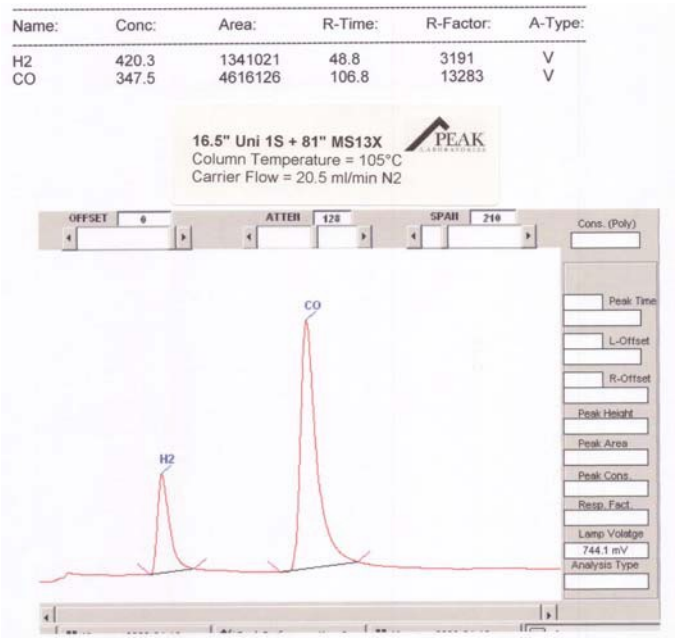


Figure 54. Standard chromatogram

The normal PP1 chromatogram (Figure 55) is affected by changes in column temperature as illustrated in comparison with the chromatogram of Figure 56.

In the circumstance of column temperature change, an increase of 30C has shifted the late eluting peak (carbon monoxide) forward. Early eluting peaks such as hydrogen are not significantly affected by changes in column temperature as interaction with column packing is minimal.

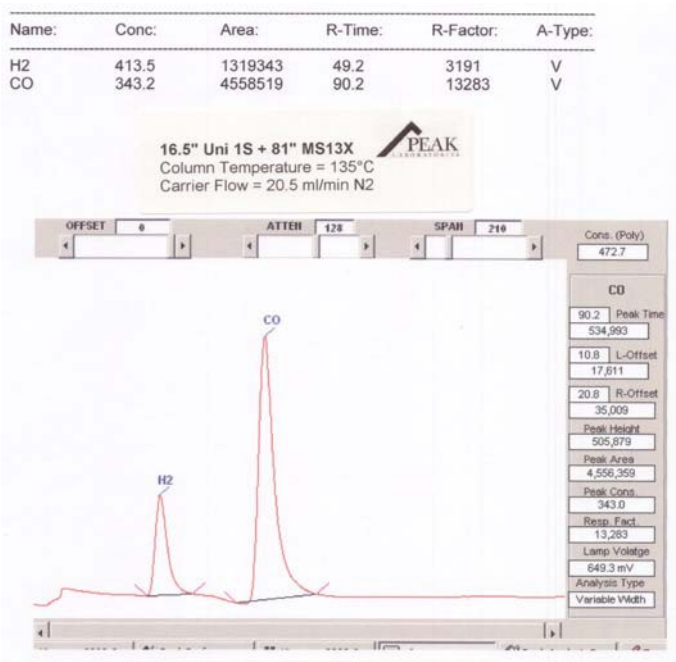


Figure 55. Effect of 30C Increase in Column Temperature

Column flow rate changes can directly affect peak retention times as peaks are pushed down the column faster or slower. Comparison of Figure 57 with Figure 55 shows the decreased peak retention times

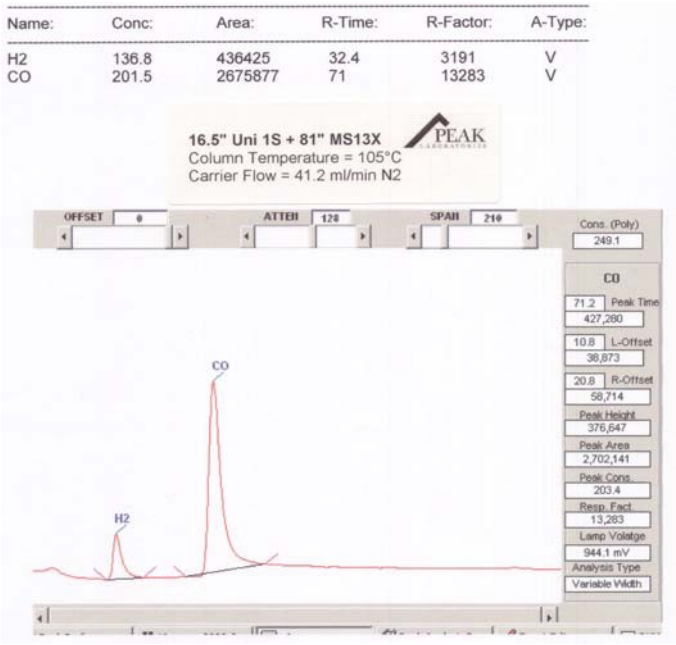


Figure 56. Effect of 2X Increase in Column Flow Rate

7.6 Peak Identification and Quantification

A typical chromatographic peak is generated by the detector's electronic signal as a function of time

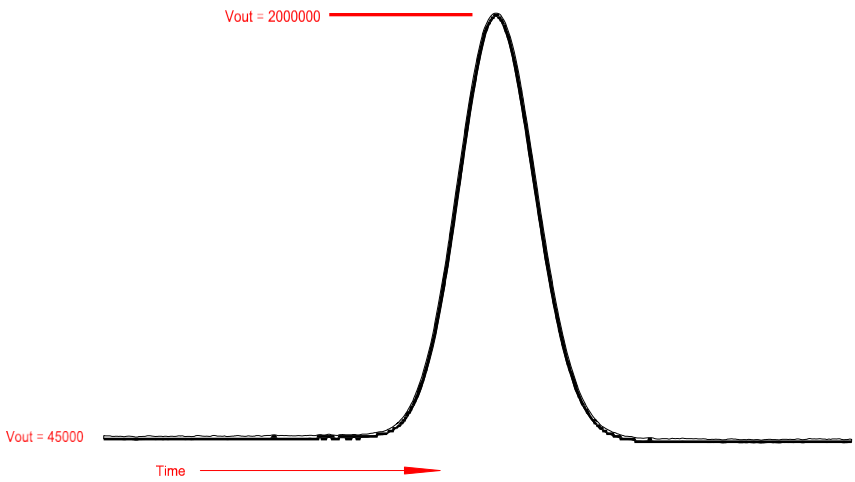


Figure 57. Typical Chromatographic Detector Signal Showing a Peak

Chromatographic peaks in the PP1 are measured by establishment of the "normal" stable detector signal, then determining the "added" electronic signal that was created by the peak passing through the detector.

Since the analyzer is monitoring the detector electronic signal over time, the "added" signal is measured in real units such as volt-sec. By virtue of a conversion factor (called the Response Factor), the volt-sec signal can be directly related to concentration units.

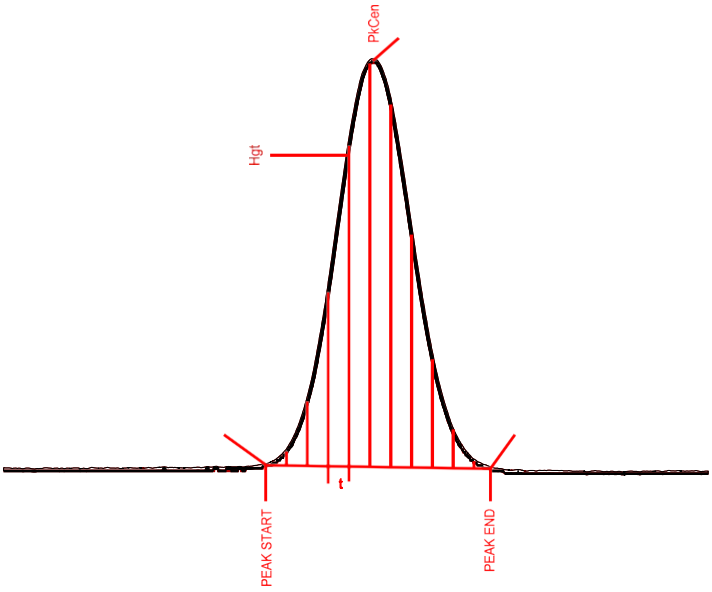


Figure 58. Illustration of Measurement of Chromatographic Peak Area

Note: The PP1 analyzer supports only area-based concentration determinations. Determinations based upon peak height as not currently available.

The first task in quantifying peaks is establishment of the “normal” stable detector signal (“baseline”). This is accomplished by determining the signal departure and return points for the peak event.

The parameters used when defining detector baseline signal and peaks are:

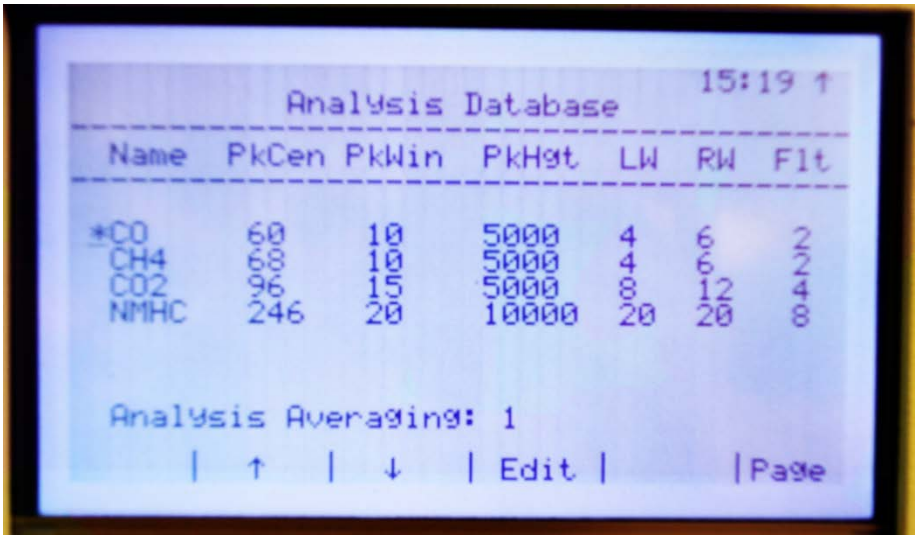

15:19
Analysis Database
Name PkCen PkWin PkHgt LW RW Flt
*CO 60 10 5000 4 6 2
CH4 68 10 5000 4 6 2
CO2 96 15 5000 8 12 4
NMHC 246 20 10000 20 20 8
Analysis Averaging: 1
| ↑ | ↓ | Edit | | Page

Figure 59. Typical PP1 Peak Analysis Database

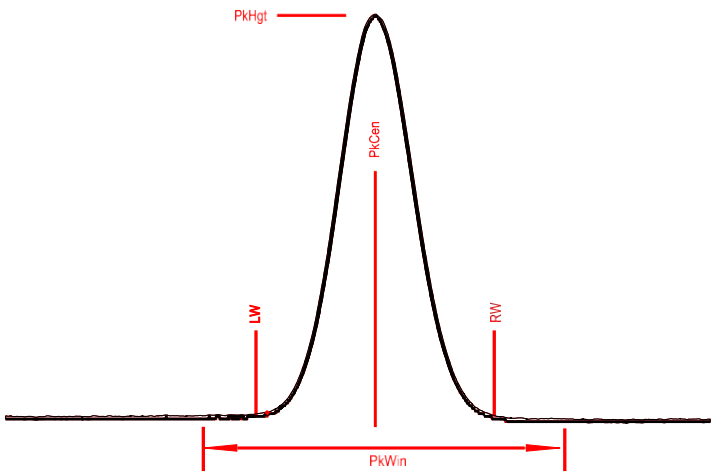


Figure 60. Illustration of Chromatographic Peak Parameters

Name = The peak identification tag, expressed as 5 alphanumeric characters (A-Z, 0-9)

PkCen = The normally expected peak retention time (in seconds), used for assigning the appropriate *"Name"*

LW = The typical time span measured from the start of the peak's baseline rise to the peak apex *"PkCen"* (in seconds). Minimum value is 3, maximum is 35

RW = The typical time span measured from the peak's apex *"PkCen"* to the end of the peak's baseline decline (in seconds) Minimum value is 3, maximum is 35

PkWin = Total tolerance window (in seconds) for assignment of a *"Name"* to a quantified chromatographic peak. The tolerance window is centered upon the "*PkCen"* value. NOTE: The peak top detection algorithm processes only the data within this window.

PkHgt = A variable for establishing the cross-over point in peak detection modes. Chromatographic peaks higher than this parameter will be quantified using the *"Variable"* mode heights, peaks with height less than or equal to *"PkHgt"* will be quantified using the *"ForceB"* mode.

Flt = The convolution filter value expressing the overall peak shape. Flt = 2 is recommended for sharp, narrow peaks such as H2, and Flt = 8 is recommended for broad peaks such as CO.

For good peak quantification, it is important to consistently determine when the peak begins (the positive increase in detector signal), when the signal maximum occurs, and when the peak ends (the return to stable detector signal).

PkCen, LW, and RW are used to establish starting and ending points for mathematical analysis of the baseline.

All modes of peak are calculation require locating the “peak top”, usually the point of maximum peak signal. In cases where the detector signal is strong, locating the peak maximum value is straightforward. Often the concentration regime of interest is the opposite case, where it is desirable to detect and extract the smallest possible peak signal.

Under these circumstances, it is advantageous to utilize signal processing techniques that magnify signal differences. Mathematical convolution is one such method. Convolution “rolls” two waveforms together as the product of data matrices, with the resulting new waveform having exaggerated characteristics.

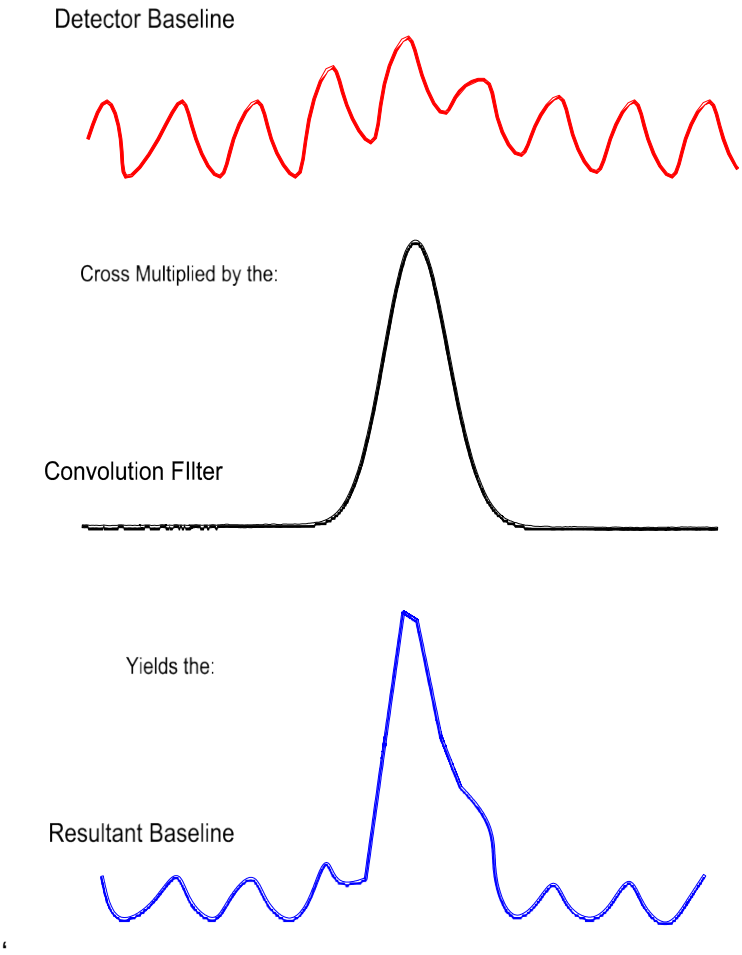


Figure 61. Convolution to Enhance Signal Characteristics

As seen in Figure 61, it is much simpler to identify the peak maximum on the convolved baseline.

Convolution functions work best when the convolving peak (filter) width closely matches the expected chromatographic peak width.

Chromatographic peak width can vary significantly depending upon column selection, detector characteristics, sample loop size, etc. Consequently, there are several different convolving peak widths available in the PP1's mathematics package; Flt =1 is the narrowest filter width, Flt =8 is the widest filter width.

NOTE: Final determination of the optimum filter width is best performed by re-processing chromatograms representing typical peaks.

7.6.1 Peak Quantification : "Baseline" Mode

When the PkHgt variable is set to zero, the Baseline Mode of detector baseline is enabled. In this mode, the normal detector baseline is calculated very simply:

Peak start time = [PkCen – LW])
Peak end time = [PkCen + RW])

All other possible aspects of peak start and end time determination are disabled and the normal detector baseline is rigidly established only by the Peak Database parameters.

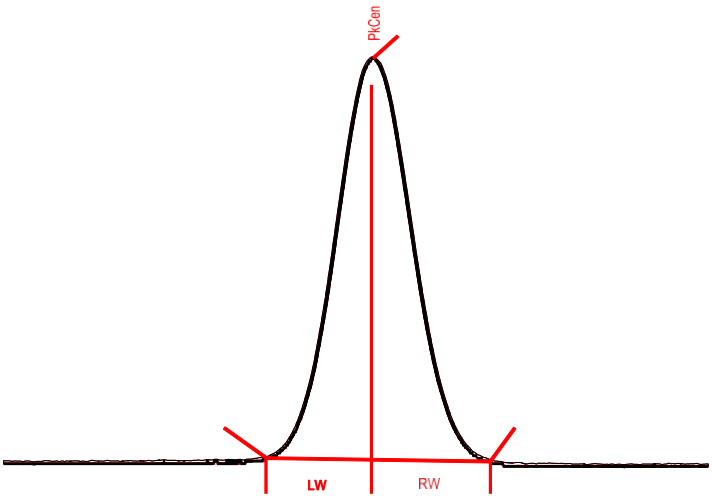


Figure 62. Baseline as Established in Baseline Mode

Peaks quantified using this method are denoted with an "B" in the last column of the data report

7.6.2 Peak Quantification: "Fixed Width" Mode

The Fixed Width Mode is enabled when the maximum detector signal value at the calculated peak maximum signal is less than the PkHgt parameter value, but is greater than zero.

The time associated with the peak maximum signal must be within the time regime of interest (= [PkCen +/– ½ PkWin]) for any peak quantification to occur.

In Fixed Width Mode, the normal detector baseline is calculated based upon the peak maximum signal time value, rather than the PkCen value.

Peak start time = [Peak signal maximum time value LW]
Peak end time = [Peak signal maximum time value + RW]

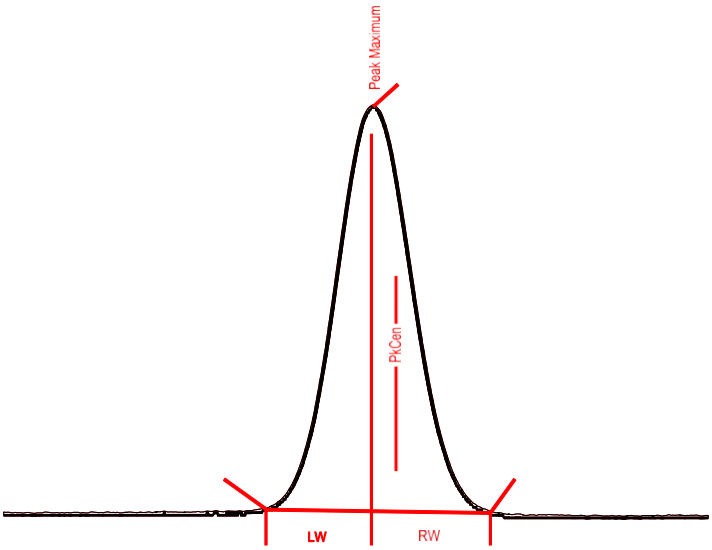


Figure 63. Baseline as Established in Fixed Width Mode

Peaks are quantified using this method are denoted with an “F” in the last column of the data report.

7.6.3 Peak Quantification : “Variable” Mode

If the peak maximum signal value exceeds the PkHgt value, the Variable Mode is enabled for determination of peak start and end points.
The time associated with the peak maximum signal is always calculated first for Forced Baseline and Variable modes by using the convolution filter to find the maximum detector signal point.

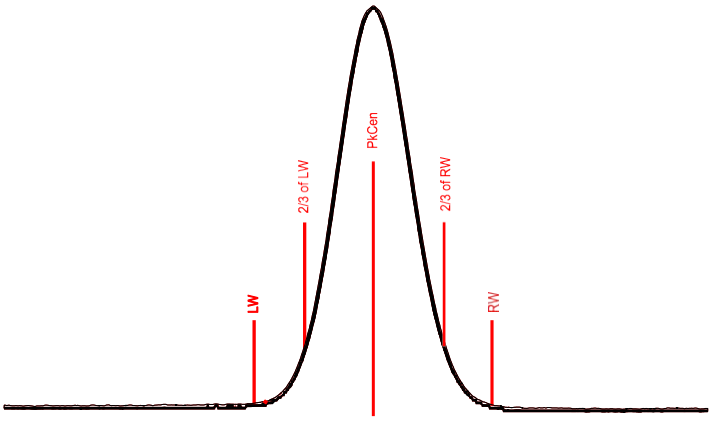


Figure 64. Initial parameters for Baseline Determination

Initially, the mathematics package makes a trial evaluation of peak area using a fixed percentage of the LW and RW values as initial baseline points, illustrated as the hypothetical baseline between points “2/3 of LW” and “2/3/ of RW” in Figure 65. The hypothetical calculation of the peak start time is labeled “L” in Figure 66.

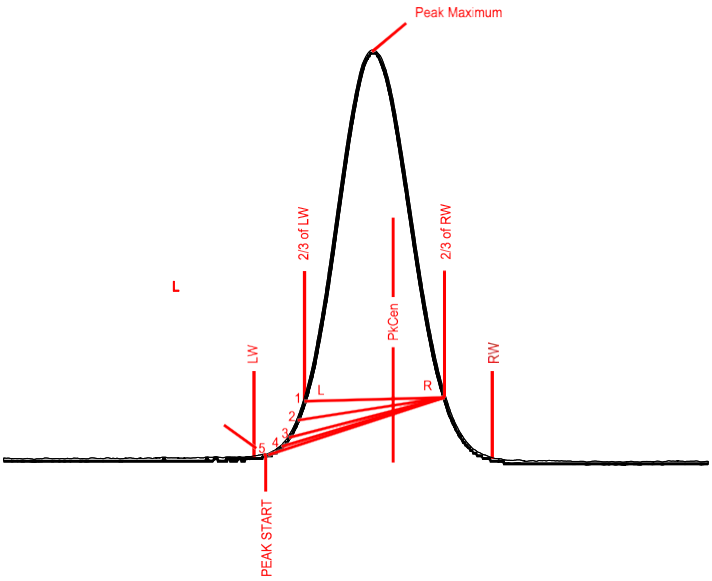


Figure 65. Progression of Peak Start Time Calculation

After calculating the hypothetical peak area based upon the L and R values, the mathematics package makes another peak area calculation, using a slightly earlier time value. The peak areas of the two calculations are compared, and if the peak area increases by more than +0.5%, the mathematics package repeats the process. The net effect is illustrated in Figure 66, where multiple hypothetical peak start points were evaluated. The final value is represented by point “5”, when the change in peak area became less than +0.5%.

The trial evaluation of peak area continues for the peak ending point, again using a fixed percentage of the LW and RW values as intial baseline points, again illustrated as the hypothetical baseline between points “L” and “R” in Figure 67. The first hypothetical calculation of the peak end time is labeled “1” in Figure 67.

After calculating the hypothetical peak area, the mathematics package makes another peak area calculation, using a slightly later time value. The peak areas of the two calculations are compared, and if the peak area increases by more than +0.5%, the mathematics package repeats the process. The net effect is illustrated in Figure 67, where multiple hypothetical peak start points were evaluated. The final value is represented by point “6”, when the change in peak area became less than +0.5%.

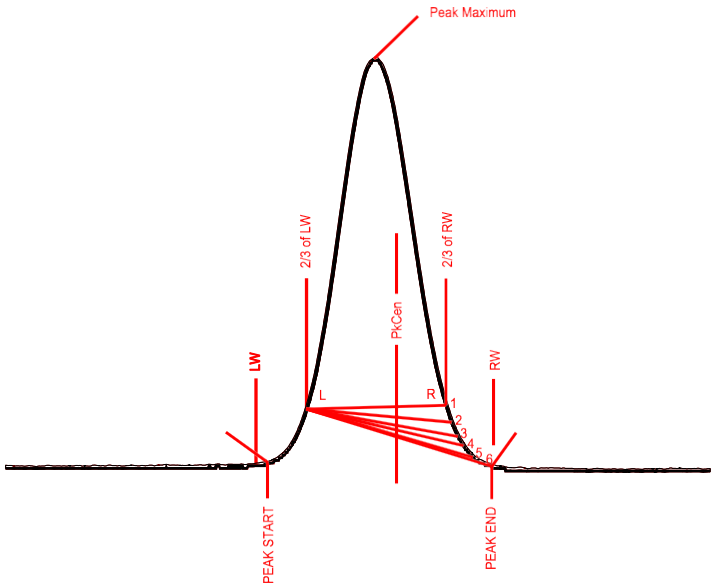


Figure 66. Progression of Peak End Time Calculation

Using the newly established peak start and end times, the mathematics package determines the “normal” detector baseline, as illustrated in Figure 68.

The signal contribution due to the peak passing through the detector can then be quantified by area calculation using time slices and signal differentials above the newly established baseline.

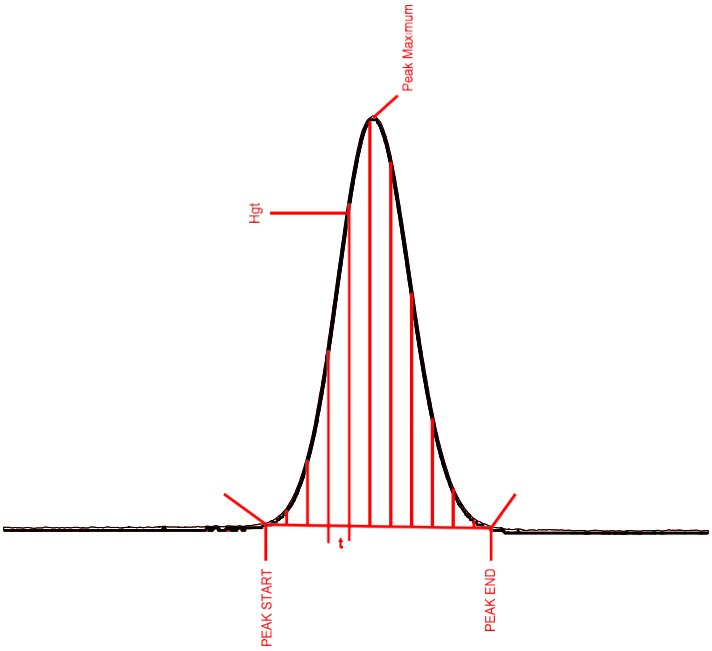


Figure 67. Peak Area Calculation

The formula for peak area calculation can be expressed as:

$$\textbf{Peak Area} = (\tfrac{1}{2} \times [Hgt_1 + Hgt_2] \times t_1) + (\tfrac{1}{2} \times [Hgt_2 + Hgt_3] \times t_2) + (\tfrac{1}{2} \times [Hgt_3 + Hgt_4] \times t_3) + \ldots\ldots$$

where:

$\mathbf{Hgt_x}$ = the signal differential between the instantaneous baseline level and the peak signal value

$\mathbf{t_x}$ = the time difference between data points

Using a constant value for $\mathbf{t_x}$, the peak area calculation simplifies to:

$$\textbf{Peak Area} = t_x \times [Hgt_1 + Hgt_2 + Hgt_3 + Hgt_4 + \ldots\ldots]$$

Peaks quantified using the Variable method are denoted with a “V” in the last column of the data report.

7.7 Chromatographic Stabilization of the Analyzer When Injecting O2 Samples

O2 samples present particular challenges for the FID PP1 analyzer due to the extreme reactivity of ~100% O2 with any possible carbon source even at relatively low temperatures via these basic reactions:

$$2C + O_2 \Rightarrow 2CO$$

$$C + O_2 \Rightarrow CO_2$$

Potential carbon sources include residual carbon within stainless steel tubing and valve bodies, polymeric valve components, and column packing materials. CO and CO_2 produced from these sources can be detected in the FID and create a wide variety of symptoms:

- Unstable detector baseline
- False positive peaks when measuring pure O_2 samples
- Difficult small peak quantification
- Transient peaks in the chromatogram

The chromatographic parameters for the FID O2 analyzers are adjusted to minimize this reactivity – the 93" HayeSep D columns used for O2 analysis are unique – undergoing an extensive set of proprietary processes for stabilizing the material for O2 service. Do not use HayeSep D columns intended for Inert gas sampling in an FID O2 PP1 – the detection limit of the analyzer will be severely compromised.

Additionally, the analytical cycle time for the FID O2 analysis is longer than normal. The column temperature for FID O2 analyzers is set at 45C to retard the carbon reactions and this creates a longer chromatographic cycle.

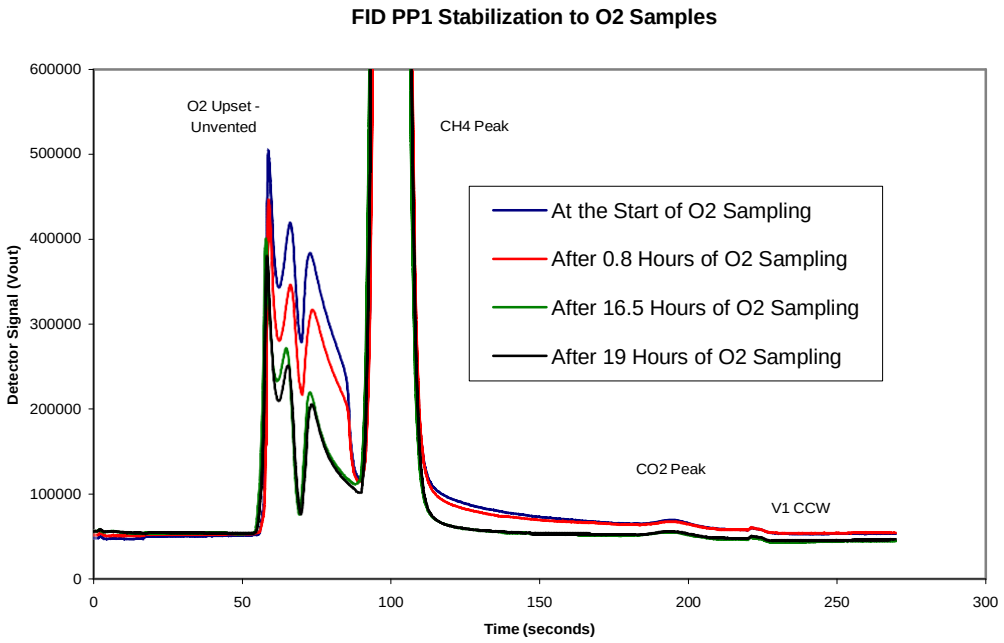


Figure 68. A Sequence of O2 Sample Chromatograms Showing Improvements With Additional Injections

Figure 69 overlays several O2 chromatograms over a period of ~ 19 hours. The overall chromatogram undergoes a significant shift as more O2 samples are taken:

- Decreasing magnitude of the O2 upset
- Improved baseline resolution at the CH4 peak leading edge
- Improved baseline stability at the CH4 peak trailing edge
- Improved baseline stability at the CO2 peak retention time

Each of these chromatographic changes will directly enhance the lower detection limit of the analyzer by making it easier to clearly define peak start / end points and peak magnitude.

These chromatographic improvements occur as the free carbon on the internal surfaces of the analyzer system is consumed. Many of the sources (i.e. polymeric valve seals) do not become carbon-free over time, however the available surface carbon can become greatly diminished with continuous exposure to O2.

Free carbon may reside within the main body of materials in the system, and diffusion forces may bring this carbon load to the surface again during idle analyzer times. Consequently, it is not unusual to see these instabilities reappear in a previously clean system after extended periods of inactivity. The new free carbon can again be diminished by continuous exposure to O2.

****CAUTION*** Under certain circumstances, the reduction of the analyzer surface carbon may be accelerated with above-normal operating temperatures

and continuous exposure to O2. As a general rule, O2 conditioning temperatures are much lower than standard conditioning temperatures – the high reactivity of pure O2 with polymers at elevated temperatures can easily destroy the valve seals and column packing materials. If O2 is being sampled, do not exceed 100C for the FID's Column temperature zone, and 325C for the Methanizer temperature zone.

To achieve maximum analyzer performance when measuring O2 samples, Peak Labs recommends continuous O2 sample cycling to minimize surface carbon reactions.

8.0 Flame Ionization Detector (FID)

**** CAUTION**** Do not begin detector heating without carrier gas flow. Damage to the detector may result.

**** CAUTION ***** The maximum Column temperature is 200°C.

** **CAUTION** ** The normal FID operating temperatures is 295°C. Maximum temperature is 350°C

The FID detector does not normally require conditioning treatment, however it does require 8 to 12 hours at normal operating temperature before flame ignition to achieve optimum stable performance.

Normal detector operating temperature for the FID is 295°C, although operating temperatures vary with the specific application.

The table below illustrates some typical compounds and detection capabilities of the FID.

Detected Compound	Typical Detection Limit
Hydrogen	No Significant Response
Carbon Monoxide	< 10 ppb
Carbon Dioxide	< 800 ppt
Methane	< 500 ppt
Other Hydrocarbons	< 800 ppt
Helium	No Significant Response
Argon	No Significant Response
Nitrogen	No Significant Response
Oxygen	No Significant Response

8.1 Flame Ionization Detector Principles

Carrier gas containing the compounds from the column passes directly into mixing tee where H2 for combustion and methanization is added. At the heated flame tip with the FID tower, this gas stream is bathed in a cylindrical flow of combustion air, and the H2 / O2 flame is ignited.

Within this flame, the following general reactions occur : *(reactions are left unbalanced for simplicity)*

$$H_2 + O_2 \Rightarrow H_2O + Heat$$

and

$$CH_4 + O_2 + Heat \Rightarrow CHO^+ + H_2O + e^-$$

Depending upon operating parameters, this reaction releases electrons until the end reaction products are reached. These electrons are collected and the resulting current measurement is used for quantification.

The net result is, in simplest terms, that electrons are released in direct proportion to the number of carbon atoms present.

$$C_3H_8 + O_2 + Heat \Rightarrow 3CHO^+ + H_2O + 3e^-$$

Therefore, instrument response is directly proportional to the number of carbon atoms present in the compound being measured.

Unfortunately, the ionization efficiency of the flame is relatively low, and roughly 1 in 10,000 hydrocarbon molecules follows the electron liberating reaction path described. The vast majority of combustion reactions follow the direct net product reaction :

$$2CH_4 + 4O_2 \Rightarrow 2CO_2 + 4H_2O + Heat$$

This reaction sequence is applicable to any hydrocarbon.

It can be seen that the FID is a “mass flow” type of detector – the number of ions created is independent of carrier flow, therefore detector response is the same regardless of carrier flow rate.

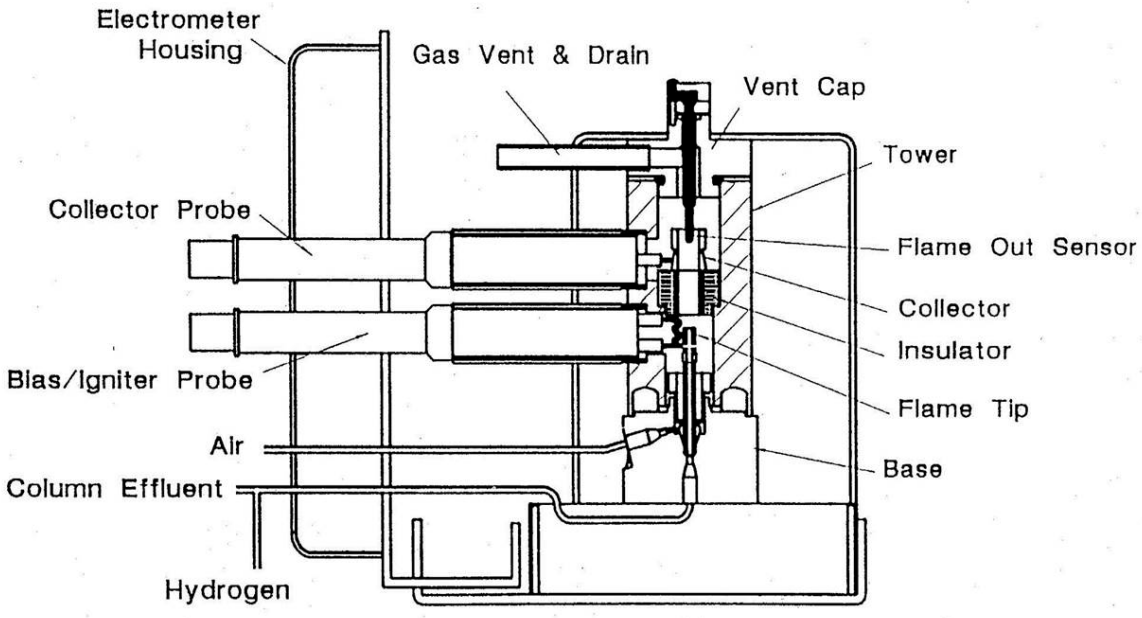


Figure 69. Standard FID Section

Normal life of the methanizer is approximately 84 months under continuous use. Replace and dispose of properly in accordance with local and federal regulations.

8.2 Temperature Effects Within The Methanizer and FID Tower

The FID Tower is heated indirectly by the methanizer block to roughly 95°C to minimize moisture condensation. It is critical to allow the FID Tower to heat thoroughly before igniting the flame. Failure to do so may trap moisture within the FID Tower and compromise the ceramic insulators.

Between the temperatures of 250°C and 325°C, this reaction on the surface of the Ruthenium Oxide catalyst can proceed:

$$CO_2 + 4H_2 \Rightarrow CH_4 + 2H_2O$$

and

$$CO + 3H_2 \Rightarrow CH_4 + H_2O$$

The rate and completion of these reactions is dependent upon temperature and residence time.

It is critical to note that the catalyst reaction can halted by the presence of moisture in the gas stream, particularly if the hydrogen for methanization has high moisture content.

Above 360°C, CO thermally decomposes on the catalyst surface and methanization is not possible.

The Peak Lab FID methanizer has been optimized for methanization of CO_2 , since under normal FID chromatographic applications, the CO peak is not chemically distinct. Peak Labs recommends the use of the RCP models for the measurement of CO as the RCP applications provide chemical specificity for CO measurement.

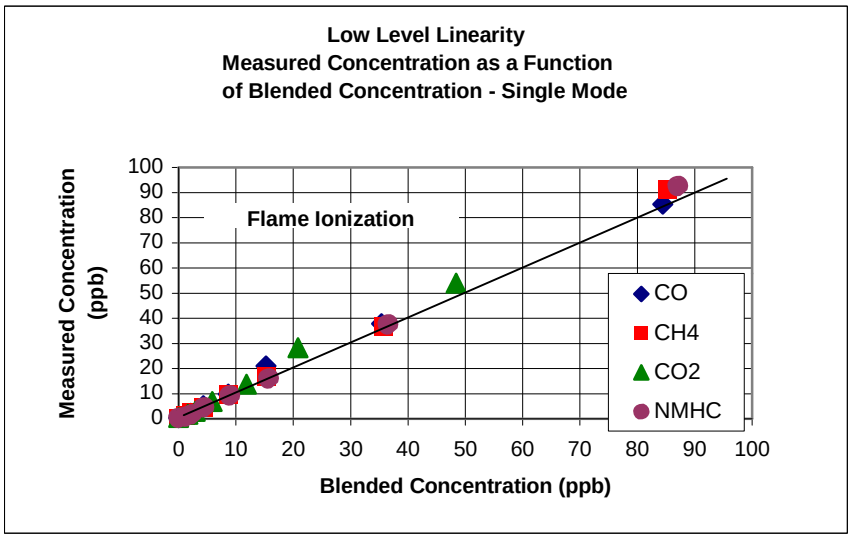


Figure 70. FID Linearity - < 100 ppb CO, CH_4, CO_2 and NMHC

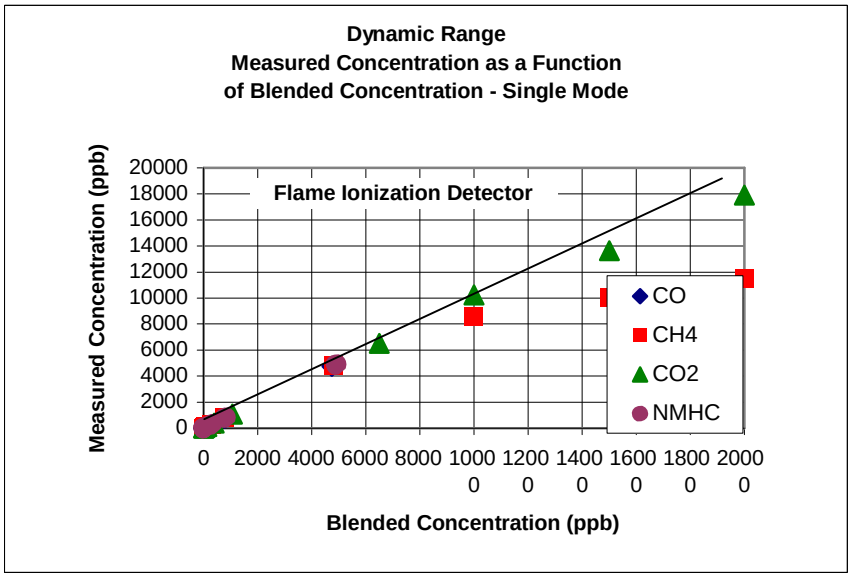


Figure 71. FID Response Curve, Showing Linear Range

8.3 Detector Flow Rate Effects

Carrier gas flow rate through the FID does not influence the rate of CH_4 ionization. However, the detector response can be influenced by the relative amounts fuel, combustion oxygen, and inert carrier gas present.

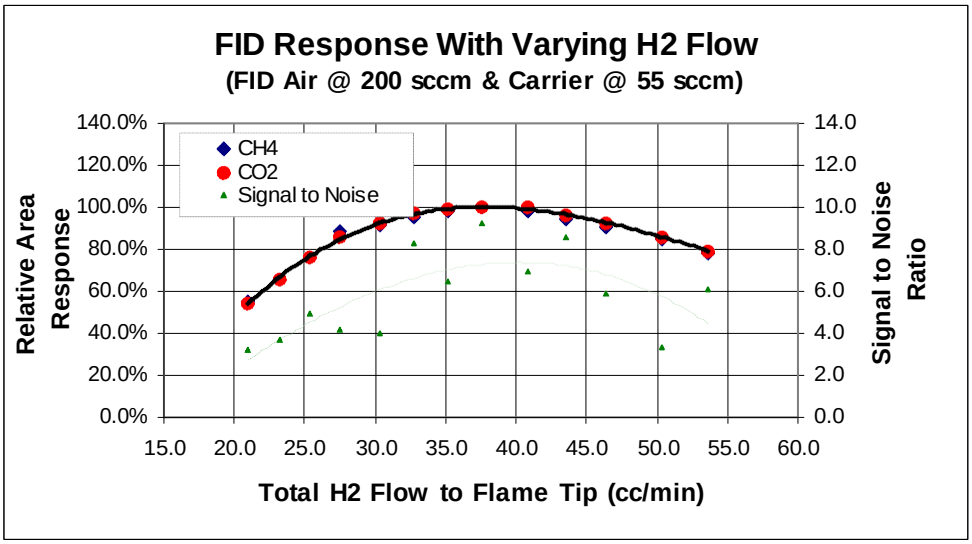


Figure 72. FID Response to Varying H_2 Flow

Note that the analyzer is relatively insensitive to H_2 flow rate changes between 33 and 43 sccm. Detector signal to noise is roughly maximized in the same regime.

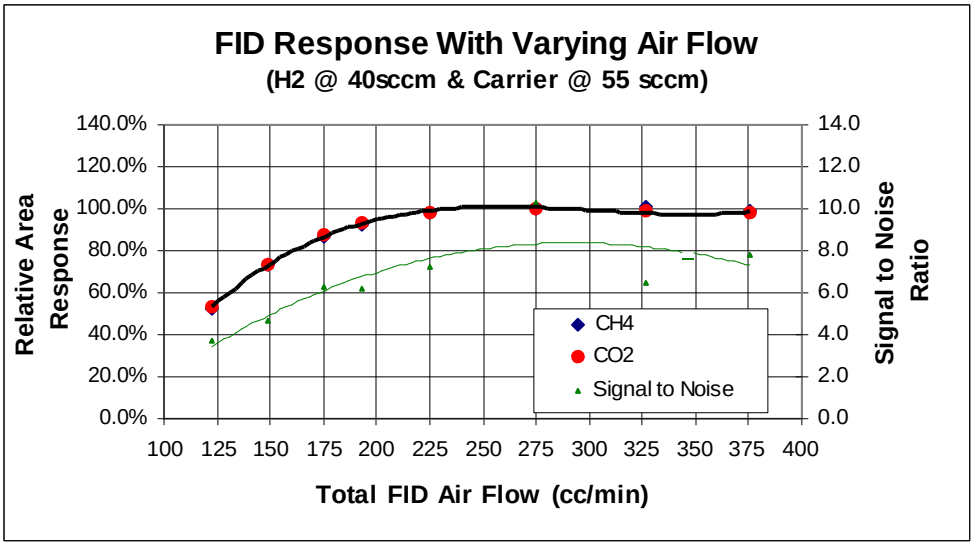


Figure 73. FID Response to Varying Air Flow

Note that the analyzer is relatively insensitive to Air flow rate above 200 sccm, and detector signal to noise reaches a stable value above 200 sccm.

Peak Labs recommends that the analyzer be operated in the flow regions that yield the most stable response and signal to noise characteristics

8.4 Resolving Random Spikes on the FID Baseline

There are two primary causes for random baseline spikes appearing on the chromatogram:

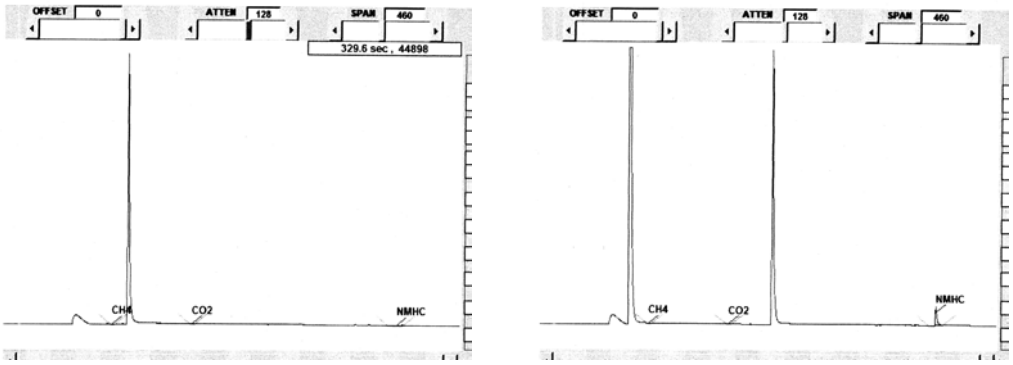


Figure 74. Chromatograms Showing Random Baseline Spikes Due to Moisture

8.4.1 Restriction of Water Flow Out of the FID Drain Line

Cause: Any restriction or reduction in size (< ¼" inside diameter), or sagging portion of the FID Drain line can create the opportunity for water bubbles to form with the FID Drain Line. These bubbles can create momentary back-pressure within the entire FID as they are forced down the drain line to the exit point. The induced pressure variations will create random, momentary spikes on the FID chromatogram.

Corrective Actions:

a) Examine the entire FID Drain Line and verify that no reduction in internal diameter occur along it's entire length.
b) Examine the FID Drain Line over it's entire length and verify that no horizontal or sagging sections where bubbles can form exists.
c) Verify that the exit of the FID Drain Line is not submerged.

8.4.2 Moisture Trapped Within the FID Tower

Cause: The flame within the FID Tower is ignited prematurely (at FID Flame < 90 C), or power was lost and the FID Tower temperature dropped below 100 C while the flame was still lit.

Under these circumstances, condensed moisture can become trapped within the FID Tower. Trapped moisture can compromise the electrical insulators inside the FID Tower and create false signal readings.

Corrective Action:

a) Reduce only the FID H2 pressure to zero to eliminate the FID Flame – this eliminates the source of moisture within the FID Tower. Keep all other flows as normally specified.
b) Increase the Methanizer temperature to 350 C for 8 to 16 hours to thoroughly heat the FID Tower and drive out trapped moisture.
c) After 8 to 16 hours, restore the Methanizer temperature to 295 C, restore FID H2 flow and re-ignite the flame.

On occasion, moisture can also become trapped under the FID Tower Cap at the O-ring seal. This moisture can be eliminated by simply removing and restoring the FID Tower Cap – the act of removal shifts the O-ring enough that the moisture is ejected. To perform this action:

d) Reduce only the FID H2 pressure to zero to eliminate the FID Flame – this eliminates the source of moisture within the FID Tower. Keep all other flows as normally specified.
e) Remove the analyzer top cover.
f) Remove the single retaining screw on the top of the FID Oven Cover.
g) Gently pull back any insulation that covers the top of the FID Tower.
h) Remove the ¼" hexagonal standoff that retains the FID Tower Cap
i) Using a pair of pliers (the cap is roughly 100 C), gently rock and lift the FID Tower Cap approximately ½" until it is completely clear to the FID Tower top surface.

j) Replace the FID Tower Cap on the FID Tower and rock gently the cap down into position.

k) Reinstall the ¼" hexagonal standoff.

l) Replace any insulation.

m) Reinstall the FID Oven Cover. Vacuum any loose insulation shreds from the instrument.

n) Reinstall the analyzer's top cover.

9.0 Analyzer, FID Maintenance and Service Procedures

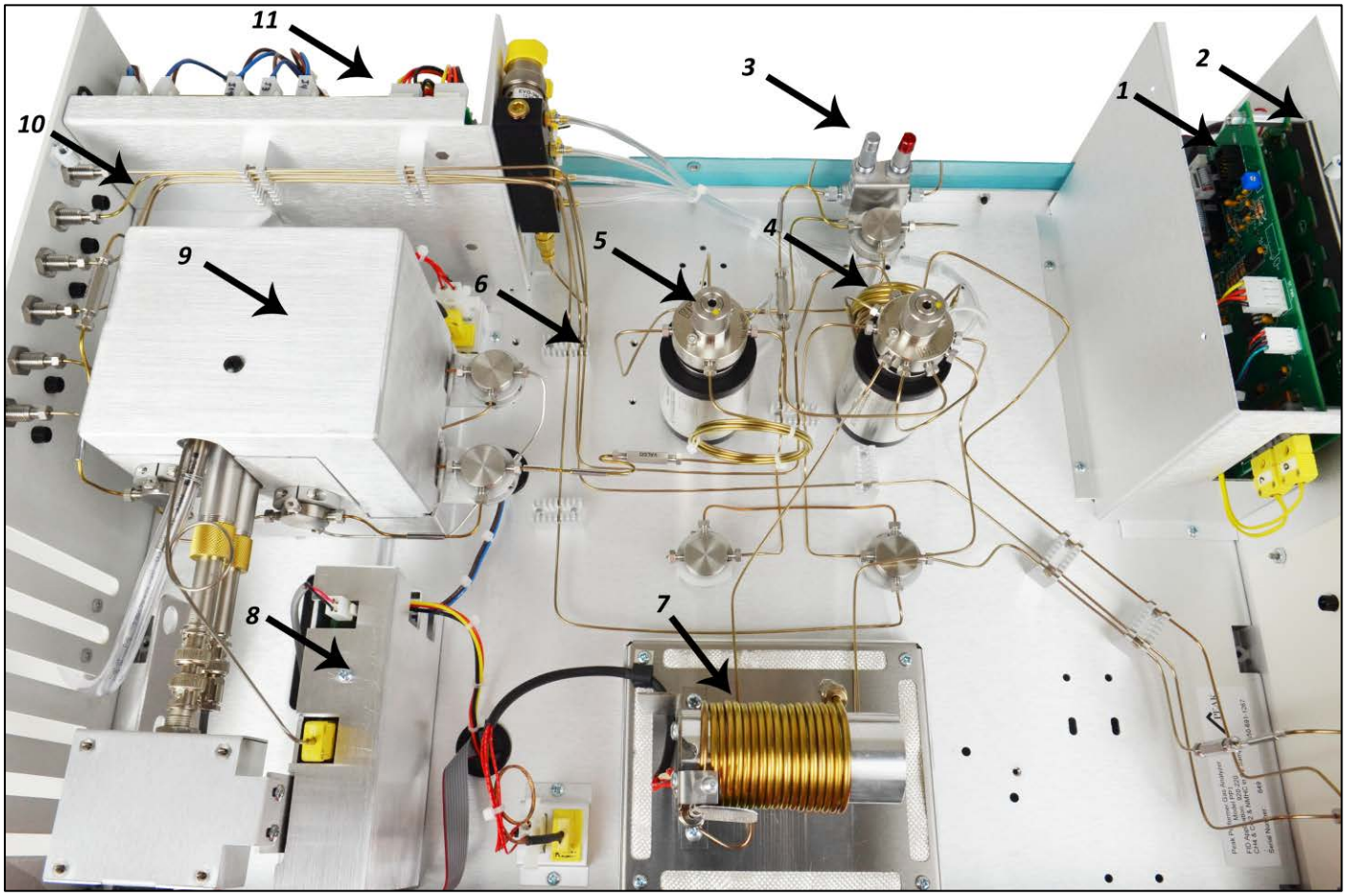


Figure 75. Chassis Overview

PEAK PERFORMER 1 FID COMPONENT LAYOUT

1. MCPU PCB ASSEMBLY
2. LCD/ TOUCHSCREEN ASSEMBLY
3. FLOW CONTROL NEEDLE VALVE ASSEMBLY
4. VALVE 1 (10 PORT)
5. VALVE 2 (4 PORT)
6. FID H_2 INLET: TO FID BASE
7. COLUMN OVEN WITHOUT COVER
8. FID CONTROLLER OCB ASSEMBLY AND COVER
9. FID DETECTOR WITH COVER
10. FID AIR INLET: TO FID BASE
11. REAR PANEL PCB ASSEMBLY (INCLUDES MAIN DC POWER SUPPLY)

9.1 Peak Performer 1 System Block Diagram

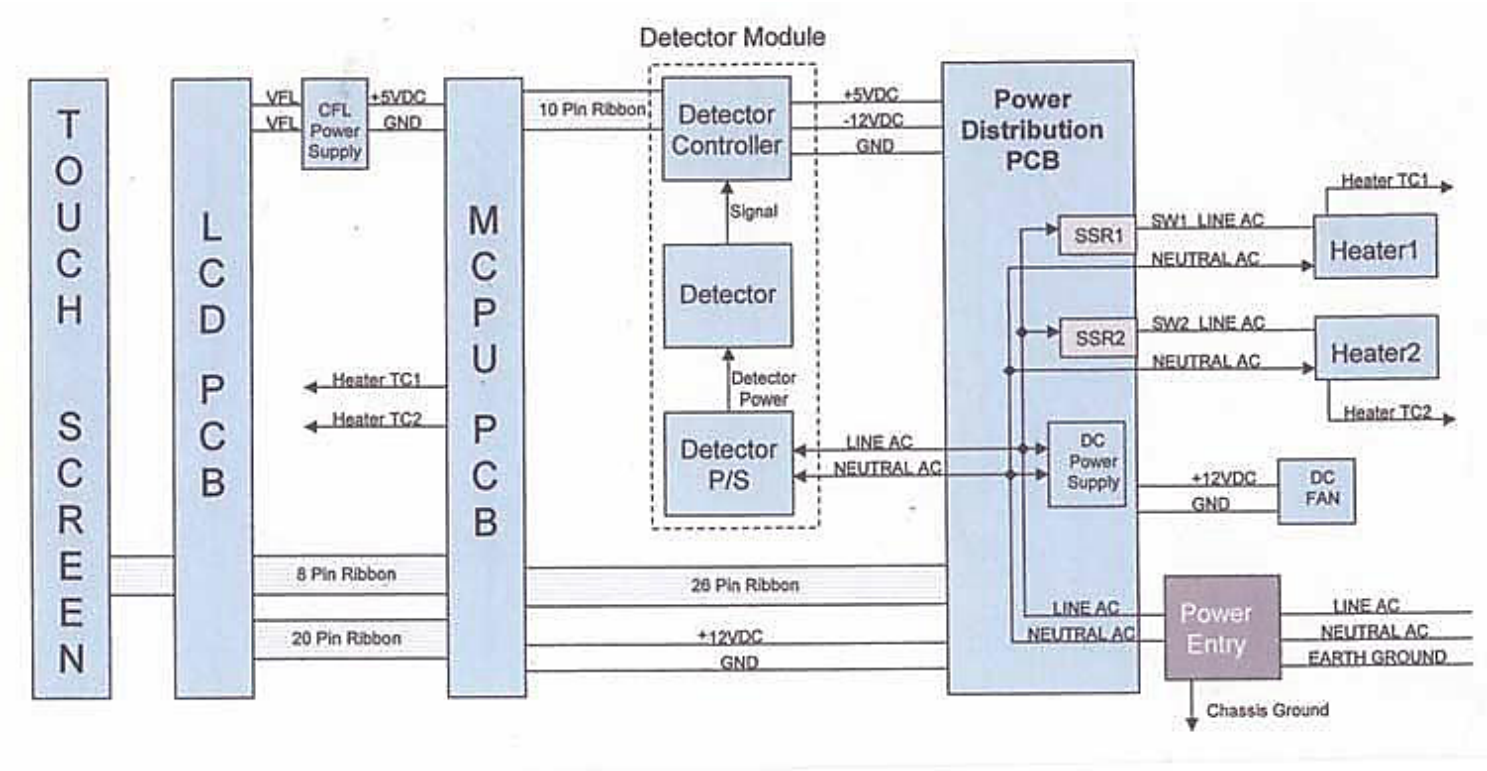


Figure 76. PP1 Functional Block and Interconnect Diagram

9.2 Monitor Regulator Pressures

Carrier supply settings should not vary. Carrier and Actuator Air settings may shift when supply cylinders run low due to “regulator creep” and should be checked periodically to maintain consistent gas flows and peak retention times.

Varying carrier pressures can cause peaks to shift out of set retention times and not be flagged properly.

Critical operating parameters are listed on the top page of the Final Test Data shipped with the analyzer. Peak Labs recommends the user create a logbook of critical parameters on a routine basis as an aid to troubleshooting.

Suggested parameters for frequent logging are:

- Analyzer S/N:
- Date and Time:
- Carrier Gas Type:
- Carrier Gas Supply Pressure:
- Carrier Gas Flow at Front Panel Bypass Out Port:
- Carrier Gas Flow at NV1 Outlet (V1 CCW):
- Carrier Gas Flow at NV2 Outlet: (V1 CCW)
- FID H2 Gas Supply Pressure:
- FID Air Gas Supply Pressure
- Actuator Gas Supply Pressure:
- Sample Gas Type:
- Sample Gas Flow at Rear Panel Sample Out Port:
- Column Set point and Measured Temperature:
- Detector Set point and Measured Temperature:
- FID Vout Signal (after zeroing):
- FID Flame Reading:
- Rfactor for compounds 1, 2, 3 & 4 (from Calibration Database screen)
- PkCen for compounds 1, 2, 3 & 4 (from Analysis Database screen)

Other critical parameters that should be verified occasionally:

- Actuator Gas Type:
- Port 1 Protocol Setting
- Port 2 Protocol Setting
- Calibration Database Screen Parameters (all)
- Analog Interface Screen Parameters (all)
- Analysis Database Screen Parameters (all)
- Event Program Editor Screen Parameters (for all active Event Programs)

9.3 Verifying Valve Integrity (Carrier Blank, Zero Gas)

In addition to periodic calibration checks, the integrity of the rotary valve seal must be tested.

Determination of valve seal quality is performed by analyzing known purified gas as a sample.

1) Connect the front panel SAMPLE IN port to the front panel BYPASS OUT port. This will begin flow of purified gas through the sample loop.

2) Wait 10 minutes to purge the analyzer completely of any residual gas samples.

3) Initiate a standard sampling run in CYCLE mode.

4) Collect 5 sample runs with Peak Viewer.

5) Average the concentration data of the 5 runs for each peak of interest.

6) Average readings higher than 1 ppb for any compound indicates a loss of valve seal integrity and possibly suggests valve head replacement is necessary.

9.4 Start-up Sequence for Replacement Methanizer

1. Allow the methanizer heater zone to cool to 60ºC
2. Turn off power to analyzer. Unplug the AC power cord.
3. Turn off the FID H2 and FID Air supplies to the analyzer. Leave carrier gas flowing at normal pressures.
4. Remove the PP1 top cover.
5. Locate the FID Module in the rear of the PP chassis.

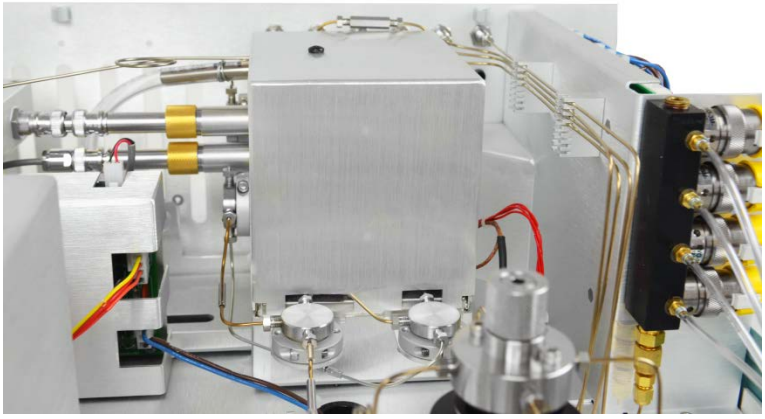


Figure 77. FID Module

6. Remove the FID oven Cover

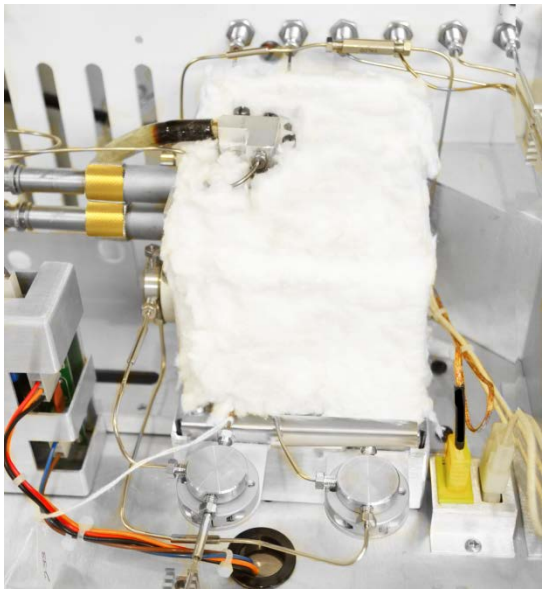


Figure 78. FID Module with cover removed

7. Remove the methanizer insulation and stuffing from the front of the methanizer heater block.

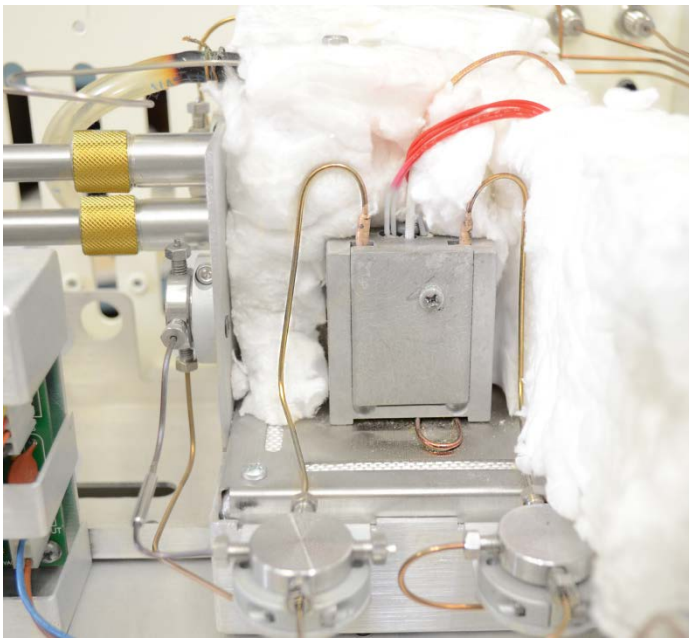


Figure 79. FID Module with insulation removed

8. Use a #2 Phillips screwdriver to remove the methanizer cover retaining screw. Remove the cover and expose the methanizer.

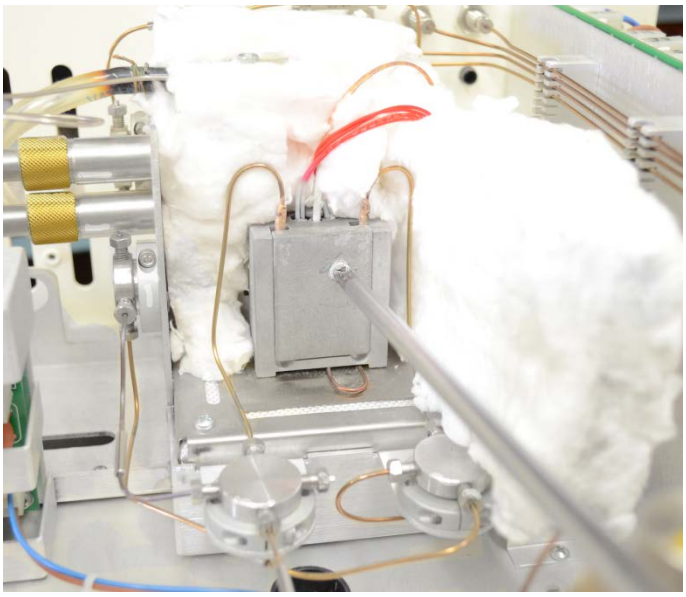


Figure 80. Removing the retaining screw

9. Vacuum insulation debris from the FID Module area and loosen the methanizer from the block with long-nosed pliers
10. Uncouple the methanizer inlet and outlet 1/16” VICI fittings from the VICI “T”s.

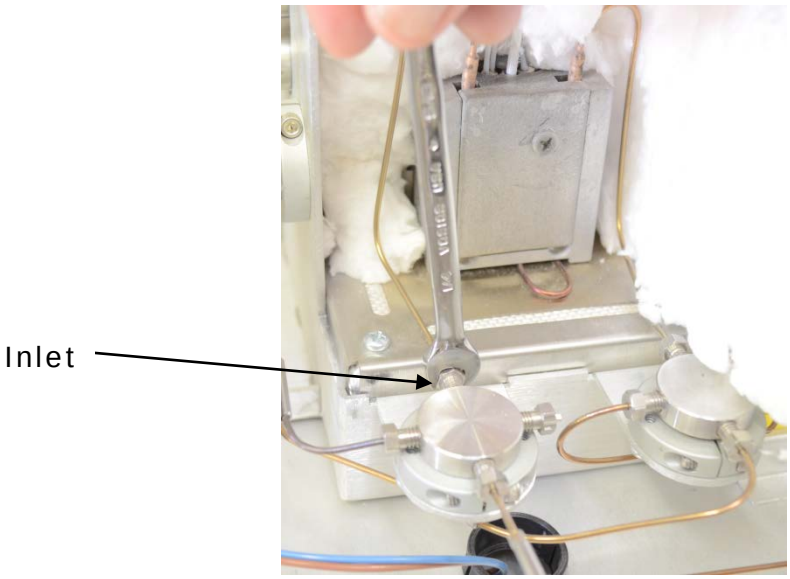


Figure 81a. Removing **inlet** 1/16” fittings from the VICI “T” s

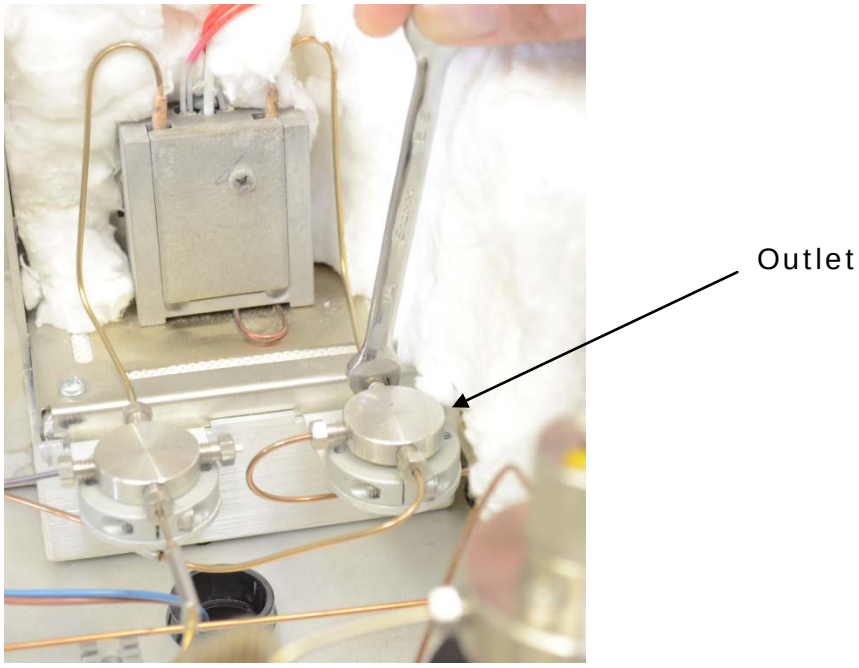


Figure 81b. Removing **outlet** 1/16” fittings from the VICI “T” s

11. Remove the methanizer from the methanizer heater block.
12. Install the replacement methanizer into the heater block.
13. Re-install the methanizer block.
14. Connect and fully tighten the 1/16” VICI fittings to the VICI “T” s
15. Re-install the FID Oven insulation, taking care to not disturb the heater and thermocouple leads.
16. Re-install the FID oven cover, making sure that the heater and thermocouple leads are not stressed and exit through the lower notch in the FID oven cover.
17. Vacuum any loose insulation remaining in the chassis
18. Re-install the PP1 top cover
19. Plug in the AC power cord, re-energize the analyzer, and turn on the Methanizer and Column heater zones.
20. Adjust the Methanizer heater zone temperature to 375ºC
21. Allow the FID FLAME temperature to reach a minimum reading of 85ºC
22. Pressurize the FID H2 supply to normal pressure (typically ~25 psig)
23. Pressurize the FID Air supply to normal pressure (typically~20 psig)
24. Ignite the FID flame.
25. The FID FLAME temperature will increase, allow it to stabilize for 4 to 12 hours.
26. After the stabilization period, lower Methanizer heater zone temperature to 295ºC
27. Allow the Methanizer heater zone temperature to stabilize at 295ºC for at least 15 minutes before running samples.

****NOTE: Full re-calibration is recommended after methanizer replacement. Refer to Section 3.6.**

9.5 Adjusting the LCD Contrast

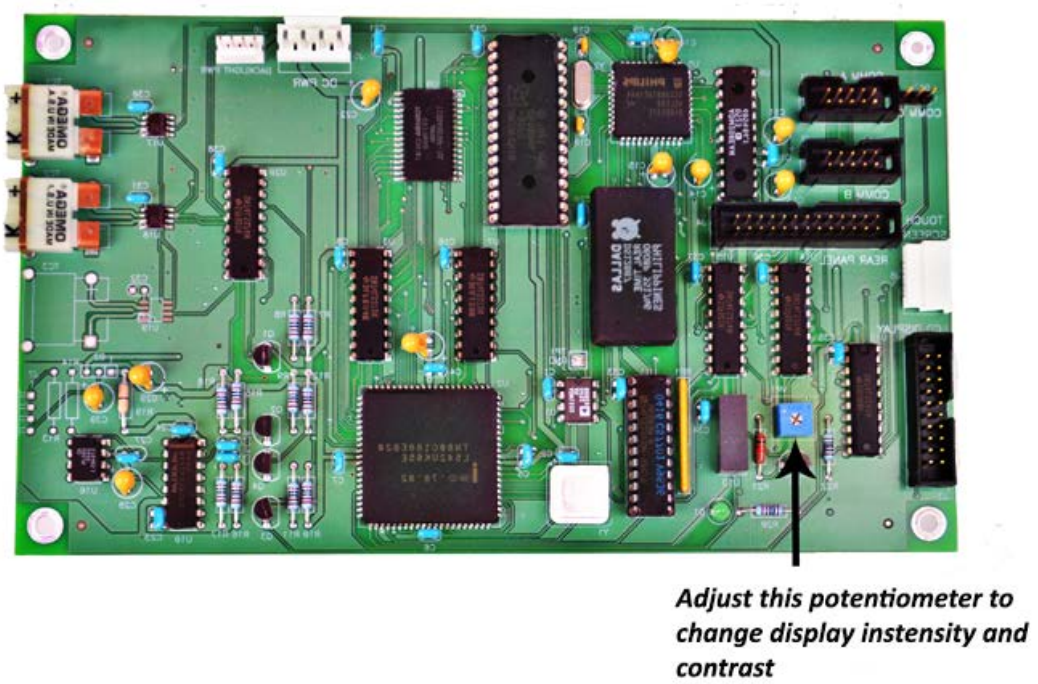


Figure 82a. View of the MCPU Showing the LCD Contrast Potentiometer
(MCPU adjustments for software versions 1-3)

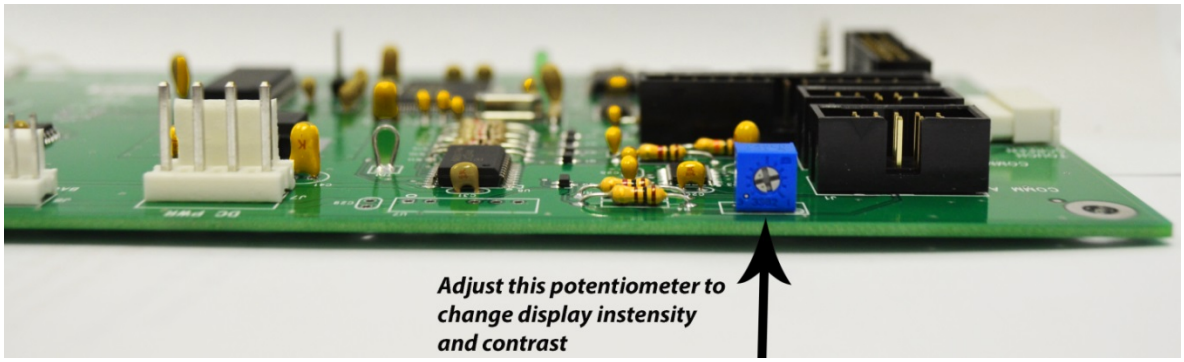


Figure 82b. View of the MCPU Showing the LCD Contrast Potentiometer
(MCPU adjustments for software versions 4 and above)

9.6 ALTERING THE ANALYTICAL RANGE OF THE INSTRUMENT

Sample loops are very easy to customize.

1) Determine the desired loop volume. Analytical range is directly proportional to sample loop size

2) Select tubing (tube internal diameter) to use. In general, use the largest ID tube possible to avoid flow restrictions.

Guidelines:

0.040" ID for 3/8 cc to 2 cc loops
0.030" ID for 3/16 cc to 1/2 cc loops
0.020" ID for 50 uL to 1/4 cc loops

Note: the shortest practical length of tubing for a sample loop is about 8 inches.

Note: Do not use tubing less than 0.016" ID as it acts like a flow restrictor, instead of a sample loop

3) The correct length for the loop tubing is calculated as follows:

Internal volume (V in cc's) = [3.142 x ID ^ 2 (in inches)] x L (in inches) x 16.38 / 4

re-arranging:

L (in inches) = 0.777 x [V (in cc's)] / [ID ^ 2 (in inches)]

an example for a 1 cc loop:

L (inches) = 0.777 x 1cc / (0.040" ^2) = 49 inches tube length

4) Measure to length, cut, and install VICI fittings
5) Blow the tube out with compressed air to remove any particles

9.7 Testing the Heater Resistance

Figure 83. Heater Resistance for 90 – 120 VAC AC Service

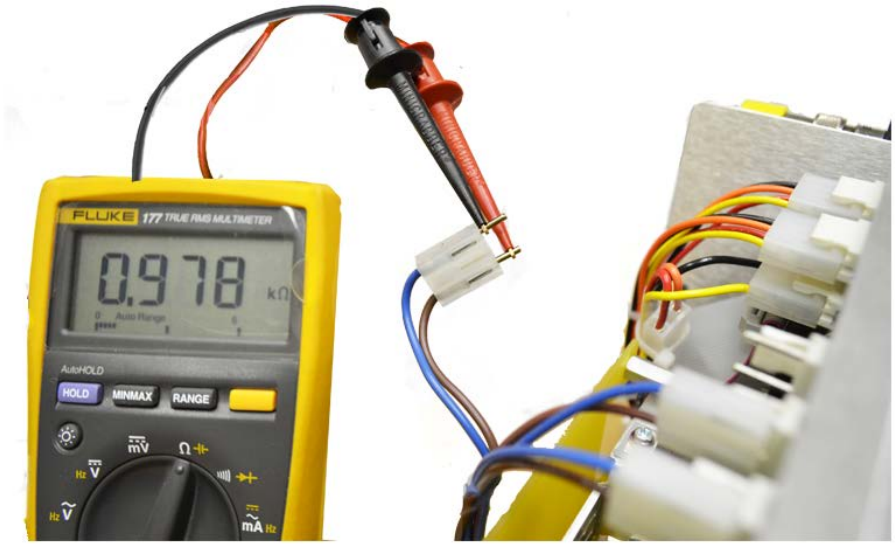


Figure 84. Heater Resistance for 200-240 VAC AC Service

9.8 Main DC Power Supply Replacement

Main DC Power Supply Replacement

Purpose:

Replace / upgrade Phihong PSA4531 DC Supply with Power-One MAP40-300 DC Power Supply

Procedure:

Power off analyzer – if gas umbilical tubing is used, it is not necessary to cool down the analyzer.
Maintain normal gas supplies.
Disconnect AC power cord.
Remove top cover.
Locate the main DC power supply in the right rear portion of the chassis –see Figure 1.

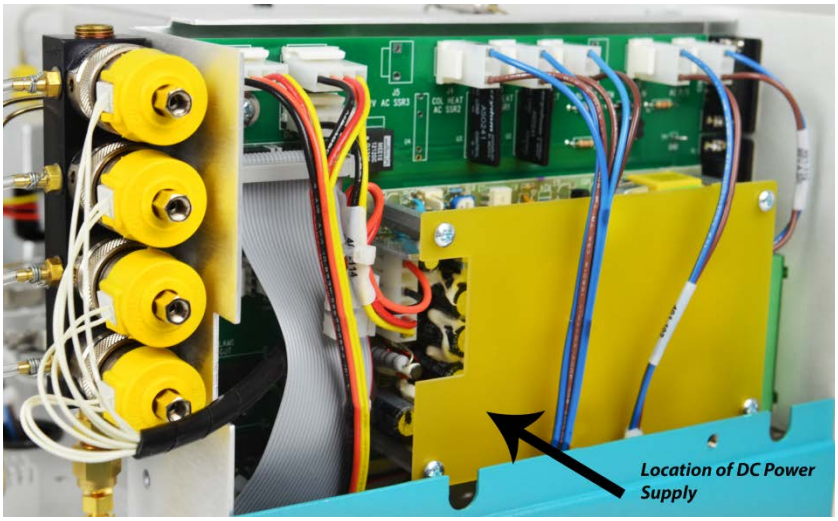


Figure 85a – Main DC Power Supply Location

Remove the 4 each 6-32 screws that hold down the plastic protective shield to expose the DC power supply – see Figure 84.

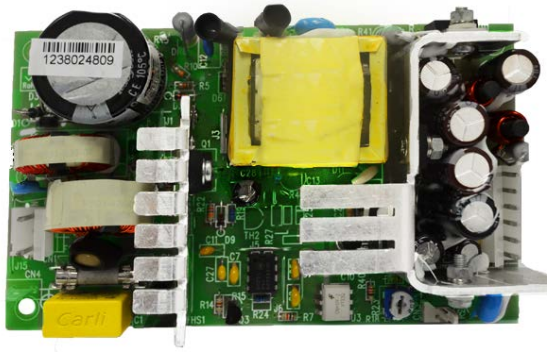


Figure 85b – Main DC Power

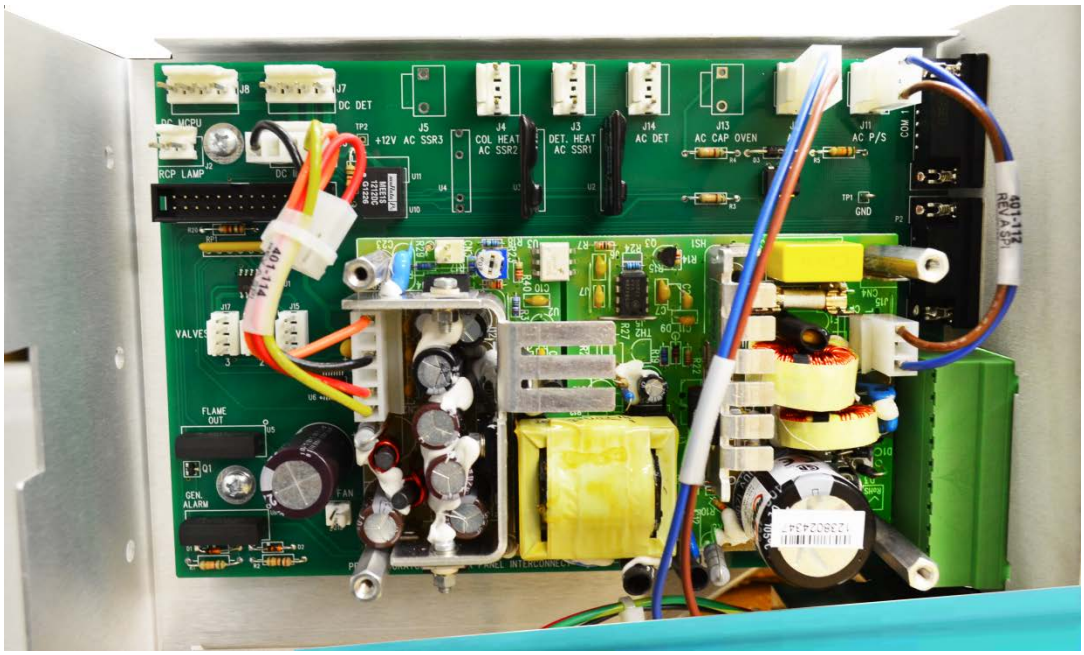


Figure 86. Main DC Power Supply with Shield Removed

Unscrew the 4 each ¼" standoffs that retain the DC power supply to the rear panel circuit board.
Disconnect only the two cable assemblies that attach the DC power supply to the rear panel circuit board – it is recommended to disconnect the cables at the circuit board connector end.
Remove the DC power supply by sliding it under the overlayed cable assemblies – do not remove the other cable assemblies – see Figure 85.

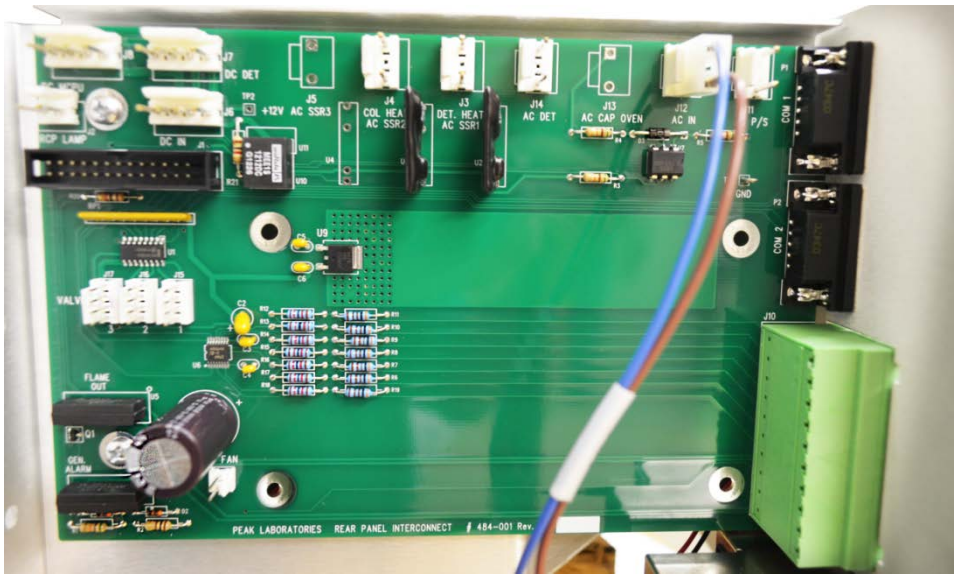


Figure 87. Main DC Power Supply Fully Removed

Lay the old DC power supply on the workbench aside the new Power-one DC power supply. Orient such that the 6 pin and 2 pin connectors are aligned – see Figure 86.

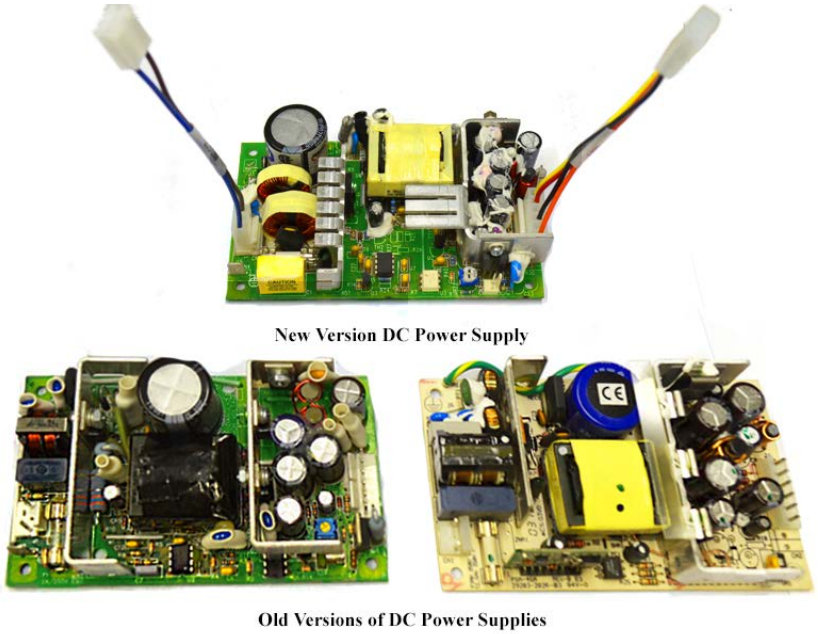


Figure 88. Correct Alignment and Cable Transfer from Old to New DC Power Supply

Transfer the two cable assemblies from the old power supply to the new supply. Install the new DC Power Supply by reversing the disassembly sequence.

After installation and power-up, it may be necessary to re-adjust the contrast on the front panel display (it may be too light or too dark)

9.9 Adjusting the 5 Volt DC Supply

***Please Note: Adjustments are not applicable for newer analyzers (Rev L. and above). Please contact your local representative for details.**

Figure 89. Adjusting the 5 Volt DC Supply

9.10 COM 1 (Viewer) Connections on Multiple Analyzers to a Single Computer

Equipment:

1 each - Computer: 1.2 GHz, 20 Gb Hard drive, 256 Mb RAM, CD-R drive, with at least 1 USB port:
(Dell Inspiron 8500 laptop or equivalent)
Operating System: Windows XP Home Edition, v2002 Service Pack 1

1 each - USB Hub: Inland "4 Port USB Hub", Self-powered, Stock #08302 (manufactured by Inland International – www.inland-products.com)

2 each - USB to DB9 (RS232) Adapter: SIIG, Inc "USB to Serial Adapter" Model # US2308, Part # JU-CB1S12 (manufactured by SIIG, Inc – www.siig.com) *Comes with installation software*

2 each - DB9 Extension Cable: DB9M to DB9F, wired straight through, 10 feet long: GQ Cables "10' Mouse/Keyboard Extension, DB9M to DB9F" Part # M05-103

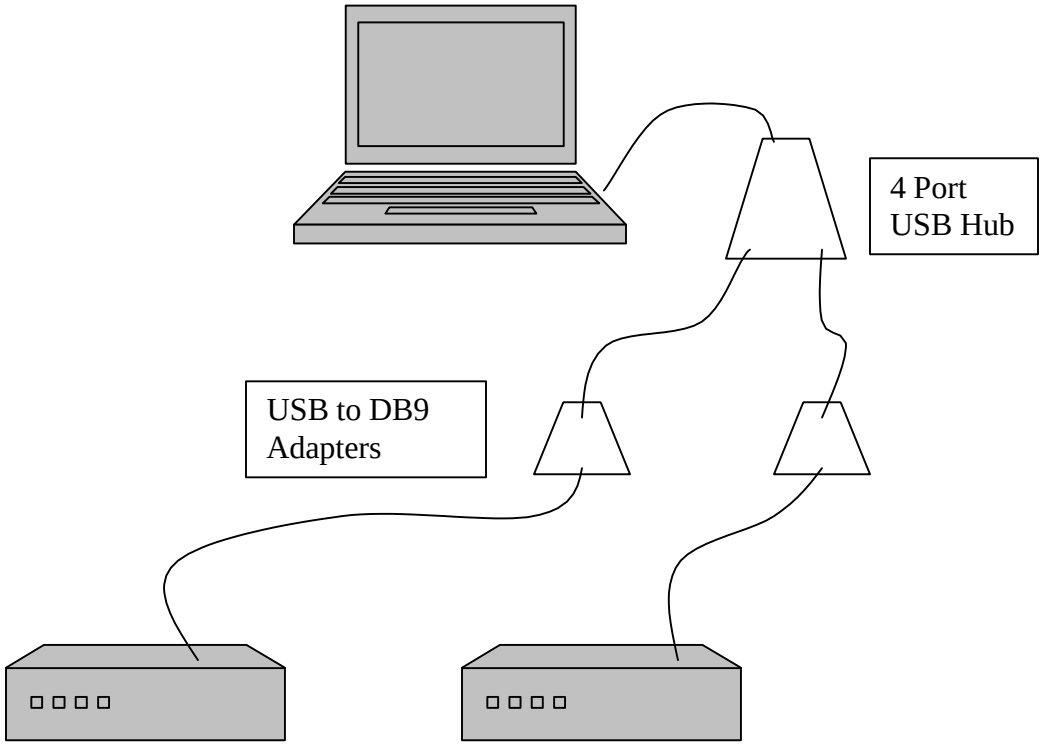


Figure 90. Multiple Analyzers Connected to a Single Computer For Using Viewer Software

Installation of Multiple Analyzers via USB:

1) Connect DB9M to DB9F extension cables to analyzers.
2) Power up analyzers – do not heat.

3) Set Port 1 Protocol on the analyzers to Viewer.
4) Insert 4 port USB hub into computer USB port – your computer should detect the connection and automatically install any required Windows drivers for USB hubs.
5) Connect the USB to DB9 adapters to the DB9 extension cables.
6) Insert first USB to DB9 adapter into 4 port USB hub – your computer should detect the connection and launch the hardware installation program.
7) Insert USB to DB9 adapter INSTALL CD in CD drive (it will launch automatically if autoplay in enabled on your computer)
8) Follow installation instructions that come with USB to DB9 adapter (I confirm that it is okay to click the "Continue anyway" box)
9) Your computer may prompt to install the USB to DB9 adapter a second time – do not cancel, it is best to let the computer re-install the software again.
10) Create a new Desktop folder for each analyzer that you will connect with a USB to DB9 adapter. Be sure to give the folders a name that relates to the analyzer that you will connect to that adapter.
11) Copy the Viewer .exe files into each new folder. Open one of the new folders and select the Viewer.exe file
12) Double-click to launch a Viewer window.
13) Go to Windows' Device Manager (Settings>Control Panel>System>Hardware>Device Manager) to see what the port assignments on your computer are.
14) In the Device Manager, click on "Ports" to expand heading so you can see what COM port number your computer gave to the USB to DB9 adapter
15) Note which COM port number is now assigned to the new USB to Serial (RS232) Port (adapter) – it's COM4 on most computers.
16) Go back to the Viewer window
17) Under "File" on toolbar, select "Port Settings"
18) Enter COM number assigned to first USB to DB9 adapter (probably COM4), check that Baud Rate = 38400, Data Bits =8, Stop Bits = 1
19) Click OK box to save these settings.
20) Communications settings for that USB to DB9 adapter will be saved in the folder and will be used automatically every time you launch the Viewer software in that folder.
21) Leave the first Viewer window open.
22) Insert second USB to DB9 adapter into USB hub – your computer should detect the connection and launch the hardware installation program.
23) Insert USB to DB9 adapter INSTALL CD in CD drive (it will launch automatically if autoplay in enabled on your computer)
24) Follow installation instructions that come with USB to DB9 adapter (I confirm that it is okay to click the "Continue anyway" box)
25) Your computer may prompt to install the USB to DB9 adapter a second time – do not cancel, it is best to let the computer re-install the software again.
26) Open the second new folder and select the Viewer.exe file in that folder.
27) Double-click to launch Viewer.exe (you might get a COM port error message window – simply click OK and proceed)
28) Go to Windows' Device Manager > Settings > Control Panel > System > Hardware > Device Manager) to see what the additional port assignment on your computer is.
29) In the Device Manager, click on "Ports" to expand heading so you can see what COM port number your computer gave to the second USB to DB9 adapter – it will be displayed directly under the note for the first USB to DB9 adapter.

30) Note which COM port number is now assigned to the second USB to Serial (RS232) Port (adapter) – it's COM5 on most computers.
31) Go back to the Viewer window
32) Under "File" on toolbar, select "Port Settings"
33) Enter COM number assigned to second USB to DB9 adapter (probably COM5), check that Baud Rate = 38400, Data Bits =8, Stop Bits = 1
34) Click OK box to save these settings.
35) Communications settings for that USB to DB9 adapter will be saved in the folder and will be used automatically every time you launch the Viewer software in that folder.
36) Viewer should automatically connect to the other analyzer.

At this point, you should have two Peak Host windows open, connected to the different analyzers.

If you run the analyzers, the chromatographic data for each analyzer will be automatically stored in the folder that matches where the Viewer.exe file is stored.